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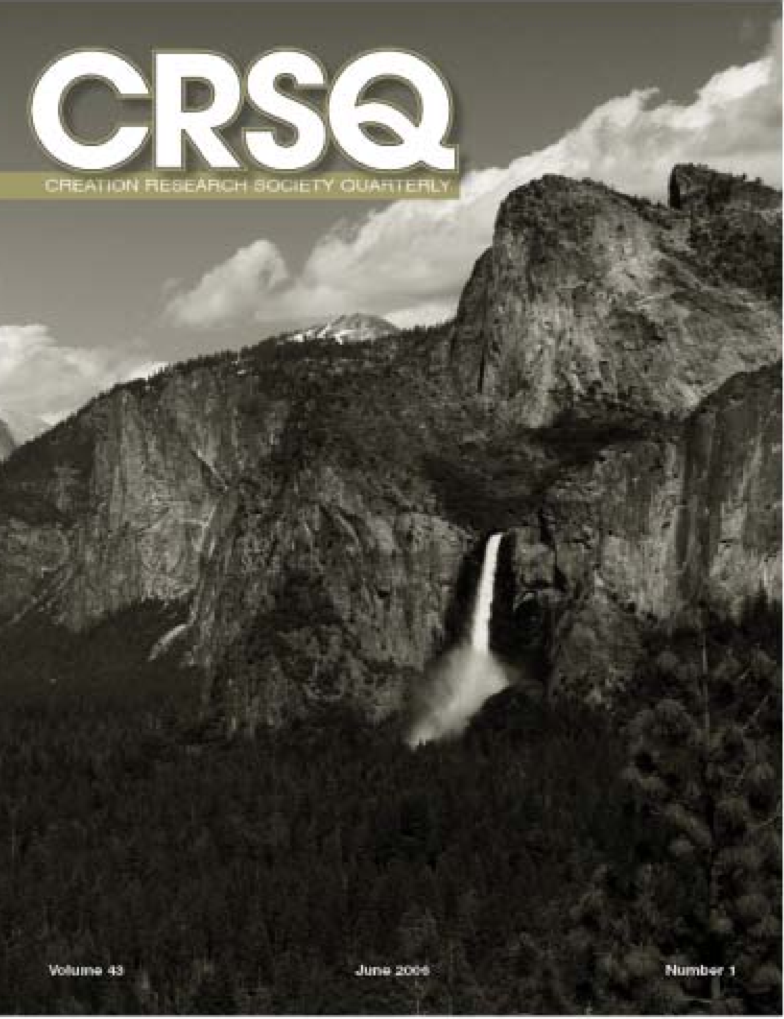

Volume 43 June 2006 Number 1

Creation Research Society Quarterly

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Articles

The Specified Complexity of Retinal Imagery 4
David E. Stoltzmann

A Critique of Progressive Creationism in the Writings of Hugh Ross 16
Jonathan Henry

Photographic Essay—The Creation Research Society Herbarium: a Progress Report 27
by George F. Howe

Isotopic Dating Maximum Datable Age.....................32
Russell B. Rotta

Photographic Essay—The Fossil Cliffs of Joggins, Nova Scotia..48
by Ian A. Juby

Departments

Editorial 1

Notes from the Panorama of Science

Update on C-14 Age Calibration............................ 54
Devonian Fish and Tetrapods Support Creation—Not Evolution.................. 55

Letters to the Editor 55
Conference Reports...56

Book Reviews

The Faces of Origins by David Herbert...................13
Genesis and the Big Bang by Gerald L. Schroeder 14
Dismantling the Big Bang by Alex Williams and John Hartnett 24, 26
One Small Speck to Man by Vij Sodera 30
A Short History of Nearly Everything by Bill Bryson.................................46
The Origin of Man by Stuart Burgess 47

Instructions to Authors...57
Membership/Subscription Application 59
Order Blank for Past Issues..60

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Haec Credimus

For in six days the Lord made heaven and earth, the sea, and all that in them is, and rested on the seventh.—Exodus 20:11

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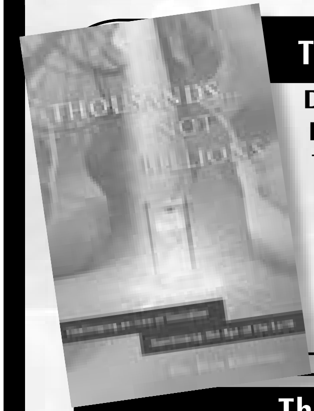
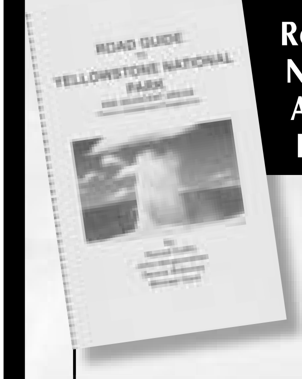


Thousands...Not Billions

Don DeYoung. 2005. Master Books, 190 pages. $14.00.
This non-technical book is the laymen's guide to the *Radioisotopes and the Age of the Earth* (RATE) project. It has been written to equip the layperson to defend scientific six-day creation and refute modern dating techniques.

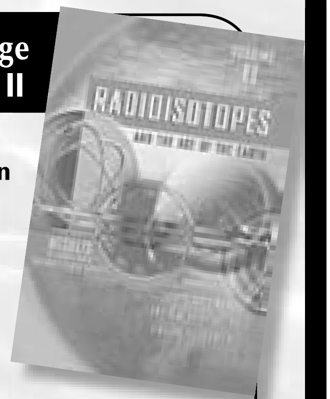
Thousands... Not Billions DVD

RATE Group. 2005. Institute for Creation Research, 48 minutes. DVD. $20.00.
See and hear the radioisotopic evidence for a young earth! Loaded with detailed animations, illustrations, and photos, this documentary summarizes the findings and amazing discoveries of the *Radioisotopes and the Age of the Earth* (RATE) Project. For advanced high school ages and up.



Road Guide to Yellowstone National Park and Adjacent Areas From a Creationist Perspective

Harold Coffin, John Hergenrather, Dennis Bokovoy, and Michael Oard. 2005. Creation Research Society, 101 pages. $12.00.
This is the second in a series of geological road guides for National Parks, National Monuments, and other significant geological regions frequented by a large number of tourists. The guide is a mile-by-mile log of significant geological sites, along with biological and historical tidbits, all from a creationist perspective. In addition to the major roads in the Park, the road guide includes the Beartooth Highway between Red Lodge and Cooke City, Montana, northeast of Yellowstone Park—one of the most spectacular drives in the United States. The guide contains numerous color pictures and diagrams of Yellowstone Park in beautiful half-page size, with a spiral binding.



Radioisotopes and the Age of the Earth, Volume II

Larry Vardiman, Andrew Snelling, and Eugene Chaffin (editors). 2005. Institute for Creation Research and Creation Research Society, approximately 876 pages. $80.00 (hard cover).
The age of the earth is an important issue in Christianity today. If the six-day Genesis account is fallacious, then how can the rest of Scripture be relied upon? *Radioisotopes and the Age of the Earth: Results of a Young-Earth Creationist Research Initiative* addresses the issues raised by the first RATE technical book in 2000. The RATE team dared to ask tough questions and has discovered that radioactive dating methods and their results are not thorough, consistent, or reliable. One of the "pillars" of old-earth evolution really supports the Scriptural account of "in the beginning."

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Editorial

Are Humans Still Evolving?

There are many areas of science and many topics of the evolution/creation controversy that are discussed in the popular press, argued between friends, and featured in various television documentaries. However, few areas generate more attention (and subsequent heat) than that of human origins. Evolutionists insist humans evolved from ancestral primates, and share a common evolutionary ancestry with all life on earth. The Creation Research Society maintains that humans were specifically designed and created by a Creator, sharing no evolutionary history with any animal or other life form.

The subject of human origins involves many scientific, philosophical, and theological questions. Following the sequencing of the human genome, one question has recently drawn significant attention in the scientific literature. Are humans still evolving? If humans have spent the last 6 million years evolving from our ancestral primates, are we still evolving today (perhaps moving onto our next evolutionary stage)?

In answer, evolutionists have recently made various claims that the human genotype is indeed still evolving. A number of evolutionists' articles have pointed to what they identify as "positive selection" toward a new human genotype. Their use of the term "new genotype" would imply an evolutionary "onward and upward" progression that will continue to separate us even farther from our primate ancestors. However, a closer look at the data reveals a very different type of "new genotype" than what evolutionists are implying.

Historically, evolutionists have pointed to sickle-cell anemia as a "beneficial" and positively selected genetic trait. Because sickle cell causes a deformity of the red blood cell (target of the malaria-causing protozoa), the protozoa is unable to infect the cell. Hence, sickle cell provides resistance against malaria, but at what cost? Those suffering from sickle cell may not die of malaria, but certainly may and often do still die young. Thus, this is analogous to cutting off a hand caught in a bear trap in order to escape the approaching bear. This is beneficial (and positively selected for) if the desire is to quickly escape the bear, but a dreadful cost has to be paid. Evolution cannot look to such "positive selection" as genetic examples of the mechanisms driving common descent (which is really what evolutionary change ultimately refers to). Loss of anything, even if transiently beneficial, is still a loss, the exact opposite of that required by common descent.

More recently, evolutionists have pointed to other red blood cell mutations being positively selected to provide malaria resistance. These new genotypes again merely represent different losses. In these cases, the loss is of specific red blood cell proteins needed by the malaria protozoa for infection (Hamblin et al., 2002; Tishkoff et al., 2001). While not as physically devastating as sickle cell, these new genotypes still represent a loss of a preexisting red blood cell protein. It is not surprising that in areas where there is a high incidence of malaria, such "loss" mutations could be positively selected for. But, the selected accumulation of such losses cannot possibly drive common descent, and will not serve to move humans onward toward our next evolutionary stage.

Another recently described example is the positive selection of lactose tolerance (Bersaglieri et al., 2004). Proper digestion of lactose (the sugar in dairy products) requires the enzyme lactase. Some individuals have lost the ability to make a sufficient level of this enzyme, resulting in a condition known as lactose intolerance (i.e., the inability to digest lactose properly). Not surprisingly, the majority of lactose intolerant people are in regions where dairy consumption has been historically low. Nor is the converse surprising to creationists; populations that historically consume large amounts of dairy products contain fewer lactose intolerant individuals. Again, this positive selection fits nicely within a creation model, and hardly provides the type of selective traits driving common descent. The evolutionists' studies do not address the origin of the lactase enzyme, merely its mutational loss in certain populations.

Other genotypic changes, such as salt tolerance (Thompson et al., 2004) and primary microcephaly (Evans et al., 2005) have also been analyzed in similar ways. The distribution of human salt tolerance corresponds with historical dietary factors, but this change is another genotypic loss. Primary microcephaly results in dramatic brain underdevelopment (skull development not unlike some specimens of *Homo erectus*). Evolutionists claim the genes preventing microcephaly are being positively selected, a conclusion with which creationists would readily concur. Again, however, neither of these studies addresses the origin of these genotypes, only selective pressure to prevent their loss.

So, once again we see evolutionists continuing to offer genotypic changes that are really the result of the loss of genes and gene functions. Yet, they repeatedly call it "evolution," as if evolutionary common descent can be achieved solely by the loss or truncation of preexisting genes. Each of the genotype changes analyzed in these studies is completely consistent with a creation model, and merely reflects the continued degeneration of the human genome (see e.g., Bergman, 2005). Hence, this newly "evolving" human genotype is actually one of degeneration (not very promising for achieving our next stage of human evolution). I, for one, continue to wait for evolutionists to finally provide examples of the mutational changes their "theory" requires, and cease this endless parade of the irrelevant and misleading. But I suspect it will be a very long wait.

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Kevin L. Anderson, Ph.D.
Editor, *Creation Research Society Quarterly*

Henry M. Morris — A Tribute

Dr. Henry M. Morris, widely recognized as the "Father of Modern Creationism," passed away on the evening of February 25, 2006, in a hospital in La Mesa, California, not far from the facilities of the Institute for Creation Research, which he had founded thirty-six years earlier. Two weeks earlier he had suffered a stroke that had impaired only his equilibrium. During the interval preceding a second stroke, he was as bright as ever but looking forward to his promotion to heaven, which came peacefully. A large crowd nearly filled the Shadow Mountain Community Church of El Cajon for his memorial on March 2. Prominent obituaries appeared not only in the local San Diego newspaper but also in many other newspapers in the United States, including the *New York Times* and the *Washington Post*. On the wall of his office for fifty years hung a plaque with only two words—*"Perhaps Today!"*

Henry was born on October 6, 1918, in Dallas, Texas. He had six children, seventeen grandchildren, and nine great-grandchildren and left behind his wife of sixty-six years, Mary Louise. He was born to a young woman who had been abandoned by her husband. She was a member of the First Baptist Church, and when Henry was still an infant, the evangelist R. A. Torrey came to the church to hold a series of meetings. Hearing of the plight of this young woman, Torrey paid her a visit. After comforting her in the Lord, he held the baby boy in his arms and prayed fervently that this little boy would accept Christ as his Savior early in life and that God would use him in a mighty way. Henry's brilliant mind, his long life of faithful service, and his unfailing devotion to the study and truth of the Word of God are abundant testimony that Torrey's prayer was fully answered.

Henry's high academic standing enabled him to obtain a scholarship to Rice University, where he graduated with a degree in engineering. During World War II he planned to join the Navy, but he received an offer to teach at Rice University, training Navy seamen in engineering. He soon realized that the theory of evolution was a serious stumbling block to the acceptance of Christ as Savior. He also recognized that the study of hydraulic engineering would help to equip him for the study of the biblical flood of Noah. He and his young family moved to Minnesota, where Henry obtained a master's degree and Ph.D. in hydraulic engineering at the University of Minnesota in 1948 and 1950 respectively. After teaching engineering at the University of Louisiana – Lafayette and at Southern Illinois University, he accepted the position of Head of the Department of Civil Engineering at Virginia Polytechnic Institute and State University, a position he held for thirteen years. This department became one of the largest in the United States. His book, *Applied Hydraulics in Engineering*, which he authored during that time, is still a cornerstone in that field.

A big change in Henry's life took place when he coauthored the book *The Genesis Flood* in 1961 with Dr. John Whitcomb of Grace Theological Seminary, a theologian with an equally brilliant mind. This book provided powerful support for the literal truth of biblical creation and the Genesis Flood and encouraged scientists who held these truths to speak out and join in common efforts. The lives of Drs. Morris and Whitcomb changed dramatically as they were thrust into the forefront and limelight of this movement and consequently were in constant demand as speakers. One result was the joining together of ten scientists at Midland, Michigan, in 1963 to found the Creation Research Society (Dr. Morris could not attend as he was at that time receiving an award in Texas). Dr. Morris immediately became one of the members of the executive board of the Creation Research Society and later served as the president for five years.

In 1970 Dr. Morris resigned his position at VPI, where he had twenty-seven professors under him, to join Tim LaHaye and Arthur Peters in founding Christian Heritage College in San Diego, where initially he had no professors under him. Morris formed a creation research unit that was an adjunct to the college, and a year and a half later it was reorganized as the Institute for Creation Research. The Institute now has twelve scientists on its staff, all but two of whom have doctorates. The Institute, along with the Creation Research Society, has provided the bulk of scientific research undergirding the creation science movement in the U.S.

During his long career Dr. Morris authored sixty books. In his last few days, he declared, "That's enough!" He seemed to have a photographic mind, as he read and assimilated an enormous number of facts and ideas. He was a marvelous writer, whose facts were carefully crafted in such a way that he never left the reader wondering just what he was trying to say. He was a gentle and humble man who never boasted or appeared self-centered.

He was never heard to tell a joke, but he had a unique ability to work humor into what he was saying, even to the last. Early in his life he loved baseball and even had an ambition to be a sports writer. After his second stroke and expecting the next would be his last, he declared, "Well, you know, three strokes and you're out!" Dr. Henry Morris is now enjoying heaven's glory, but he will be greatly missed by friends and family and by the millions who have read his books and heard him speak. "Well done thou good and faithful servant."

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The Specified Complexity of Retinal Imagery

David E. Stoltzmann*

Abstract

An optical image is a very organized and specified collection of information governed by the laws of optics. The formation of an image, and its correct interpretation by sighted living creatures, is a unique example of the great complexity in the living world. While many other functional features of living organisms are extremely complex and point to the handiwork of a designing God, an optical image demonstrates a unique mapping process of the eye-brain system that is very useful to the organism. The transfer of light from an object scene to a visual detection system involving the eye and brain conveys an enormous amount of information. Unless that information is correctly organized into a useful image, however, the exchange of information is degraded and of questionable use. In this paper I examine the "connections" necessary for images to be interpreted correctly. I also address the additional complexity required for the dual-image mapping involved in stereovision. Statistics are presented for "simple eyes" consisting of a few pixels to illustrate the daunting task facing random-chance, purposeless, undirected evolution in the origin of any form of a functional eye. It is concluded that evolutionary processes cannot account for the perception of images by living organisms and that only a creator could produce complex visual systems.

Introduction

The object-image mapping process is quite complex and ubiquitous throughout nature in sighted creatures. Many organisms have the additional capability of overlapping fields of view providing for stereovision and depth perception. How imagery of one eye can be correctly sampled and reassembled to form a good image is truly remarkable, while correlating two separate images, one from each eye, is astoundingly complex. It is worth examining the intricacy of this image-mapping process to determine if random processes could effectively account for the origin of vision.

The object-image mapping process seems to be dealt with sparsely in the literature, if at all. DeYoung (2002) touched on this issue to some extent by describing an insect that has multiple eyes, each of which has a separate retina. The mapping process for that insect's visual system first needs to invert each retinal image and then combine the various images into one contiguous field of view. For other *Creation Research Society Quarterly* papers dealing with eyes and vision, consult the references of Crofut and Seaman (1990), Hamilton (1985, 1987a, 1987b, 1988, 1991, 1993), and Sherwin and Armitage (2003).

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The Human Eye Compared to Images from Digital Cameras

The human eye (Hecht, 2002; Walker, 2000; and Smith, 1990) is roughly a 25-millimeter diameter sphere with a retina that contains about 120 million rods (black and white sensitive receptors) and about 6 million cones (color receptors). The region of greatest acuity is the foveola, which contains about 15,000 cones and is centered in the fovea. Today's digital cameras use a sensor made up of picture elements called "pixels," each of which detects light intensity, gray scale, and color. One could think of the structures of the retina in terms of pixels that sample the retinal image, as depicted in Figure 1. By "sample" I mean that the image falling on the retina gets divided into a large number of individual picture elements (pixels), all of which must be reassembled by the brain to reestablish a good image. Thus, the foveola could be thought of as a 125 by 125 pixel camera. At first glance this seems to be a very small number of pixels compared to today's rather ordinary eight megapixel sensor cameras, which have something on the order of 3500 by 2300 pixels in their field of view (FOV). But the total "pixel" count for the human eye is about 126 megapixels, far beyond the 8-megapixel camera example. The cones of the fovea are individually connected to nerve fibers for high-resolution imagery. In this paper I will deal mostly with human eyes, but the basic premise will apply also to other sighted species with various forms of vision, such as compound eyes.

The Information Content of the Retinal Image

A couple of decades ago, images were analog for the most part, residing on a piece of film, or perhaps projected onto a screen. But with the advent of digital cameras, today's images are assembled by piecing together a large number of discrete pixels, each pixel making up only a small part of the overall image. When a digital image is finally assembled, the electronic and mathematical process involves a basic form of what is called "image processing" (Berry and Burnell, 2000), where each pixel's contribution to the final image can be changed or enhanced by many techniques. For example, the intensity of the output from a pixel can be increased, decreased, stretched, changed in color, etc. Noise (dust, scratches, low contrast) can be reduced by a number of mathematical techniques when all of the pixels are combined into a final image. But, no matter how the output from an individual pixel is changed, its precise location in the image itself must be preserved if no distortion (mapping error) is to be tolerated. Thus, image processing involves all of the details needed to first break an analog image apart into digitized components (pixels), perhaps then performing some image enhancement to the signal coming from each pixel, and finally reassembling the pixels in the right order to obtain a faithful representation of the object from which the image was made. In the human visual system, all of this image processing happens on a continuing basis over time. As the eye moves, the field of view changes, the lighting conditions vary, and the chemicals of the retina are continuously altered by the absorbed photons themselves.

A ballpark number for the image processing power of the human visual system can be estimated by the critical flicker frequency (CFF), which can be thought of as akin to the number of film frames projected per second by a movie theater projector. A standard TV updates the screen with 30 frames per second, for example. A retinal image digitized by ~100 million rods and cones responding at a modest CFF for a human eye of 10 pictures per second, results in a human image processing system that must deal effectively with ~10^9 responses per second. In this sense, the old adage is certainly true, that "an image is worth more than a

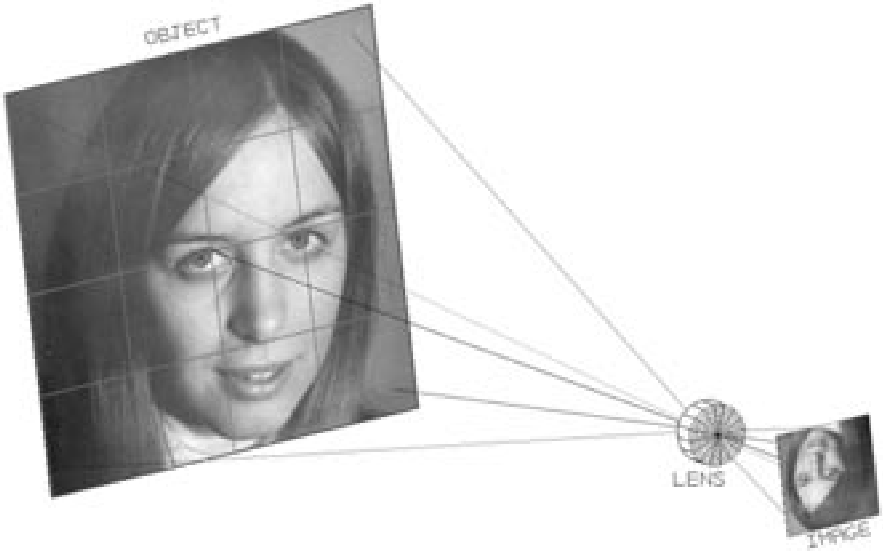


Figure 1. An object scene is viewed by a lens and an inverted image is formed in the focal plane of the lens. In a digital camera, a grid of light-sensitive elements (pixels) divides the image into a matrix. In the human retina, the matrix of rods and cones must be correctly connected to the brain in order for the image to be faithfully restored.

thousand words," and an image from each eye (stereovision) even further compounds the image-processing task. The information transfer from an object scene to a sighted creature's visual processing system is enormous and perhaps difficult to appreciate when simply calculating the previous approximate numbers.

Trying to Make Sense of the Image

The real problem for the human visual system is to "wire" the image processor such that the visual information transfer is done correctly to yield a good image by which the perceived scene is a faithful representation of the object (Figure 2a). Figure 2b shows a scrambled version of the same pixels from Figure2a, one of 2500 factorial ($2500! = 10^{7411}$) possible rearrangements or permutations of the 50 by 50 pixel array. An important question for an evolutionist to consider is how likely it is that the correct image arrangement of Figure 2a can be produced by "trial and error" processes in a visual system.

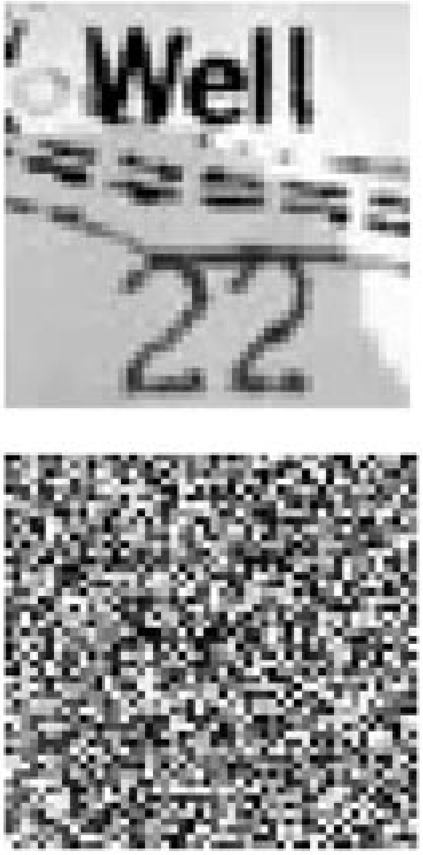


Figure 2. 50 by 50 pixel image of a small section of a topographic map. The correctly digitized (scanned) image is shown in (a), while the scrambled pixels shown in (b) represent one redistribution of the 2500! (1.63×10^{7411}) possible permutations of the pixels for this image. 50 by 50 pixels is roughly 1/6th of the foveal FOV for human eyes.

Examining the First Principles Only, with No Medical Details

In this paper I intend to provide examination of some first-order statistical numbers that help to constrain a visual system in terms of its complexity. The eye itself is not unlike a digital camera in that it samples an image through photoreceptors at a given frame rate, and is connected to an image processing system that attempts to make sense of what is being viewed. My use of terms such as "wired" or "pixel connections," is merely for descriptive purposes as an actual organic vision system does not function in this precise fashion. A rigorous medical model is not being discussed here because it not only exceeds the purposes of this paper, but also because those additional biochemical and organic details only compound the problem of how an image is formed and has its content ultimately transferred to the brain for processing and interpretation. I will try to reduce a very complicated organic miracle to a much simpler engineering model, which will help demonstrate the complexity of sight based solely on correct image mapping. For the purposes of this paper, a rod or cone (pixel) gets connected to the brain (computer), and an image is nothing more than a collection of pixel connections that establish a FOV. Clearly, a living organism's visual system does not have pixels or direct wires that connect rods/cones to the brain. Many reference resources for the eye (Anonymous, 2005; Frisby, 1980) are filled with elaborate descriptions of the actual neural pathways and components that contribute to making an image; the reader is directed to these sources.

The evolutionary problem can be framed simply in terms of a digital camcorder hooked up to a television monitor. The camera (eye) views an object scene and sends the video information to the display (TV) in a specifically coded sequence such that the digitized images are ultimately organized and displayed as a "good image" on the monitor (the brain). This mapping process, from object scene to displayed image, could produce everything from a "perfect" image having complete correlation from object to image (Figure 2a), to a corrupted image such as the "snow" in Figure 2b, as well as anything in between. The details of the "wiring" of the camera to the processor are not important to the discussion here. I am evaluating only the final mapping of the output image compared to the input object scene in order to determine the quality of the image being presented by the complete system. This "mapping" of object scene to perceived image is the unique feature of a living visual system, and it is this mapping that will be the focus of discussion.

Some Statistics for Wiring the Eye by Random Chance

A 12-pixel Image

The number of possible combinations that an eye-brain system has in connecting all the rod/cone receptors is an astounding and virtually unknowable number. I shall start with a single wire

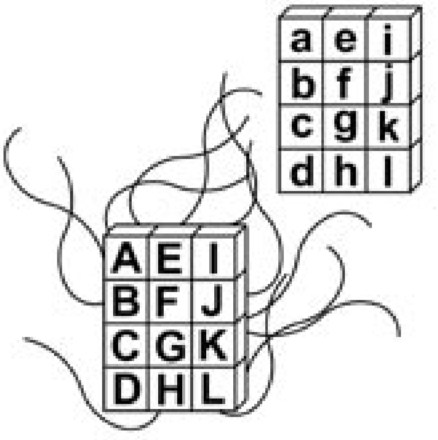


Figure 3. A 12-wire connection example where the same capital letter to lowercase letter is the correct connection, and all others have some level of error.

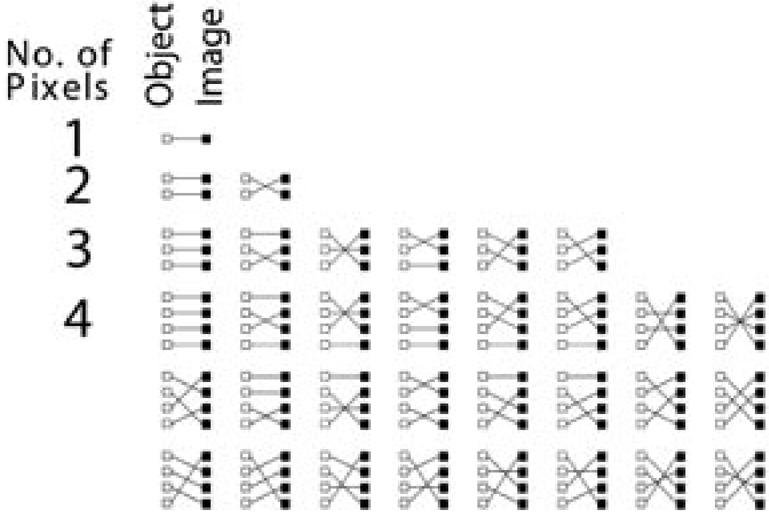


Figure 5. Wiring connection permutations for 1, 2, 3, and 4-pixel "eyes."

connection and then add additional wires for each additional "pixel" on the retina we wish to connect. Figure 3 shows an example of this kind of "eye-brain" wiring, for the case of 12 wires that need to be connected.

The correct connection of wires in the example shown is to have A-a, B-b, …L-l pairings, such that an "image" that falls on the pixels in the capital letters block gets correctly transmitted to the lower-case block in exactly the right order. There are 12 factorial (12! = 479,001,600) permutations available in trying to make the connections, a task not easily accomplished by chance. Figure 4 shows how an "image" of the letter *F* would appear for the 12 pixels shown in Figure 3. If the connections are not done right, however, what could be expected for the quality of the image in cases of incorrect wiring? There are almost 500 million permutations possible for the 12 pixels to be wired in different ways. To reduce the permutations to a manageable level, I shall start with some even simpler examples having fewer connections.

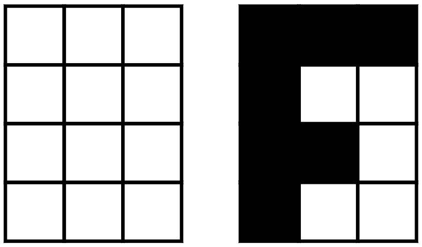


Figure 4. A letter 'F' image on the 12 pixels shown in Figure 3.

Some Statistics for Simple "Eyes" Having 1-4 Pixels

Figure 5 shows the possible connections for pixel counts ranging from one to four. For one pixel there is only one possible connection that can be made, so the accuracy of the image in this case is 100%. A one-pixel image is not very useful but is accurate in its connections.

For two pixels, there are two possible permutations: a correct wiring, and a completely incorrect one. The correct wiring has a 50:50 chance of occurrence. For three pixels, there are 3! = 6 possible permutations, in which only one is correct, three have one correct wire in place, and two are completely wrong. In the case of four pixels, there are 4! = 24 possible permutations. Only one case is completely correct for all four wires; there are six cases where half the wires (two) are right, eight in which only one wire is right, and nine in which none are correct.

Examples of 1-11 Pixel "Eyes"

Figure 6 shows the results of cases for pixel counts ranging from 1 to 11. The trend is very clear: once the number of pixels starts to become more than just a few, almost all of the random wiring attempts are incorrect. Ignoring the left-most column of M, the first four columns tabulate the same number of permutations previously discussed. In the other seven columns of Figure 6, it becomes apparent that for larger numbers of pixels, the number of incorrectly connected pixels grows rapidly. At seven pixels and upward, very few correctly-wired pixels are added to the list in comparison to the huge number of additional incorrectly wired cases.

In Figure 7, the statistics for the case of 11 pixels have been listed and graphed to illustrate the trend of how the numbers are tracking (see Appendix 1 and 2). Where M is the number of correctly wired pixels, in the case of

The table values group the number of possible pixel connections within the total number of 'N!' permutations for 'M' correctly-connected pixels. For any given column, the number of possible connections must sum to N!, and there are never any M = (N-1) correct pairings.

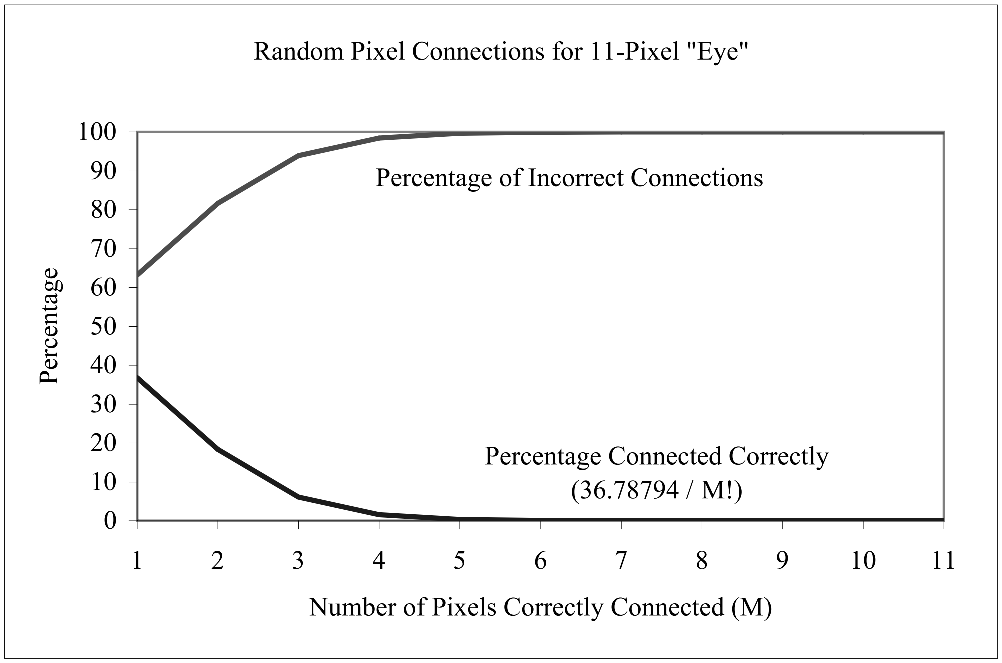
11											1
10										1	0
9									1	0	55
8								1	0	45	330
7							1	0	36	240	2970
6						1	0	28	168	1890	20328
5					1	0	21	112	1134	11088	122430
4				1	0	15	70	630	5544	55650	611820
3			1	0	10	40	315	2464	22260	222480	2447445
2		1	0	6	20	135	924	7420	66744	667485	7342280
1	1	0	3	8	45	264	1855	14832	133497	1334960	14684571
0	0	1	2	9	44	265	1854	14833	133496	1334961	14684570
M	N = 1	2	3	4	5	6	7	8	9	10	11
	N! = 1	2	6	24	120	720	5040	40320	362880	3628800	39916800

Figure 6. Distribution of correctly wired pixels for a 1 to 11-pixel "eye."

M=1 there are a little less than 37% of the available permutations that have no correctly wired pixels. The number of singly wired correct pixels (M=1) is also about 37%. Adding these two percentages results in about 73.5% of the available permutations that have either one or zero correct connections. The percentage of correctly connected pixels falls rapidly as M gets larger, while the sum of the percentages for the incorrectly wired pixels quickly nears 100%, as shown in Figure 7.

The percentage of correctly connected pixels is given by: 36.78794/M! percent, a relationship that can be determined empirically by evaluating the tabulated numbers of Figure 6. As M increases, M! in the denominator increases exponentially resulting in a pixilated FOV wherein very few of the pixels are correctly wired. Without the Lord's designing hand in creating the coded information for correct image mapping, no random or "trial and error" process could have accounted for the phenomenally accurate imagery that sighted creatures have.

M	Percentage	Percentage Incorrectly Connected
0	36.78794	
1	36.78795	63.21206
2	18.39396	81.60603
3	6.131366	93.868677
4	1.532738	98.467169
5	0.306713	99.693434
6	0.050926	99.948906
7	0.007440	99.992701
8	0.000827	99.999088
9	0.000138	99.999899
10	0.0	99.99999
11	0.000003	99.999999



Percentage of permutations which have 'M' pixels correctly connected

Number of pixels correctly connected

Figure 7. Statistics for randomly connecting an 11-pixel eye.

The Convergence of Percentages for Correctly-Connected Pixels

It is somewhat surprising that the percentages tabulated in the second column of Figure 7 remain almost constant for increasing numbers of pixels in the FOV. These values obtain more significant digits of accuracy as the pixel count increases, but essentially the values given in Figure 7 represent the situation for any large number of pixels in the FOV. No matter how many pixels there are in the FOV, the percentage of correctly connected pixels remains fixed at 36.78794/M! percent. For a large number of pixels, the net evolutionary result would be possibly a few correctly connected pixels, but these would be lost within a huge ocean of incorrect connections. The visual system ultimately cannot tell which pixels are correctly wired and which are not, because the image tends to just look like noise. This intriguing aspect of the percentages converging to 36.78794/M! percent is shown graphically in Figure 8.

The remarkable aspect of the trend shown in Figure 8 is that it is very improbable to obtain more than a handful of pixels correctly connected regardless of the number of pixels in the FOV, if chance evolution itself were responsible for having created the visual system. In the case of a 12-pixel FOV, for example, there are 12! possible permutations (479,001,600) of the pixel connections and only 1.5% of these will have four pixels correctly connected, as seen in Figure 8. In the case of the actual human eye fovea, which has 15,000 pixels, only 1.5% of those connection permutations would have four pixels correctly connected too, based on chance alone. Conversely, about 98.5% of the connection possibilities will be incorrect for the situation in which four pixels are hooked up right. So, for the case of the human fovea, how is the visual system supposed to be able to find those four correct wirings in the midst of the other 14,996 incorrectly wired receptors? If more than four correct connections are desired, the percentages depicted in Figure 8 drop by the factor of M!, which exponentially limits the possibility of having a "workable" portion of the FOV provide a useful image. As an analogy, consider a town of 15,000 homes, only four of which have the correct addresses. It would be very difficult indeed to find the four correctly listed homes among the others. That is the same problem the brain would have in finding the correctly mapped rods and cones within a huge number of mis-wired receptors, if evolutionary mechanisms were used to first establish and then preserve the visual system.

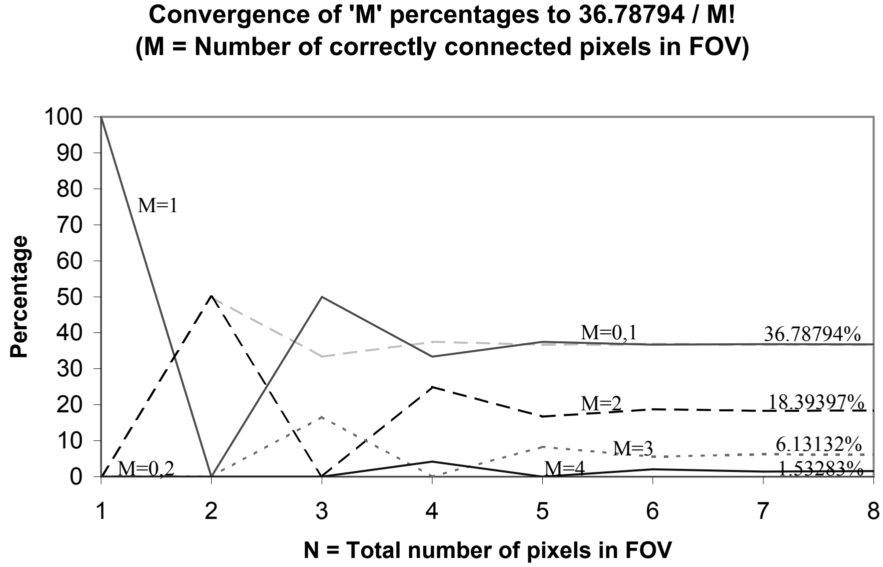


Figure 8. For 1-4 correctly connected pixels (M), the percentages of the pixel-connection permutations quickly become constant with increasing numbers of pixels in the FOV. The same trends apply to values of M>4 where the percentages converge to 36.78794/M!.

Looking at More Complex Eyes

Almost all of the wiring combinations for an 11-pixel eye result in fewer than 6 pixels being correctly paired. Thus, 99.9% of all the combinations are incorrect wirings: a staggering concept for any chance-based process of image formation in a visual system. For the case of 11 total pixels, if roughly half the FOV needs to be wired correctly to arbitrarily make a "good" image, then a 6-pixel level shows that over 99.9% of the attempts to connect these six pixels correctly will be in error. Virtually all of the almost 40 million possible permutations for 11 pixels will be wrong, with less than half the FOV being wired correctly. In addition, if only one-fourth of the FOV needs to be wired correctly to constitute a "good" image, then the 3-pixel level of Figure 7 shows that over 93% of the possible permutations would still be wrong and would not give a good image in at least one-fourth of the FOV. So, even an 11-pixel FOV creates a situation in which the groups of 6 pixels or less having correct wiring represent 99.9% of the available combinations, and these percentages will not change as the number of pixels increases higher than 11. In the situation of 18 pixels in an "eye," where six correctly wired pixels would represent one-third of the

FOV, 18! permutations will have more than 6 x 10^{15} possible connections, and 99.9% of these will be wrong. So, more than two-thirds of the FOV will be incorrectly wired.

Extending this reasoning from 18 pixels to 60 pixels (less than an 8 by 8 pixel FOV) gives more possible permutations than the estimated number of particles in the universe (10^{80}), where 60! = 8.3 x 10^{81}. Again, 99.9% of all these possibilities will be the wrong combinations for six pixels out of 60 (1/10th of the FOV). Figures 6 and 7 show the difficulty of getting more than 6 correct connections out of 99.9% of the available possibilities by chance, and for any reasonable number of pixels in a visual system, the number of wrong connections quickly becomes staggering. The inverse of this huge number of wrong connections represents the "zero" probability of wiring a real eye by evolutionary processes. The same reasoning applies to any digital camera, so that no engineer would ever attempt to wire a digital imaging system by any random or "trial and error" process. What is the basis for the assumption that simply attempting "trial and error" over millions of years would eventually produce the human eye?

"Connecting" the Pixels of the Human Fovea to the Visual Processor (the Brain)

For the case of the high-resolution center of the fovea, where there are 15,000 pixels, the number of combinations (15,000! = 2.75 x $10^{56,129}$) is not a comprehensible number. Trying to correctly wire 15,000 pixels by a "trial and error" process is not realistically possible, and it would never be possible to get any part of the FOV of the eye to form an image that would be useful. Six correctly connected pixels leave over 99.9% of the $10^{56,129}$ combinations which are incorrect, and the odds are even worse for the chance origin of more than six correctly wired pixels. Random wiring would produce an image not unlike the snow of a TV screen tuned to a nonfunctioning channel (see Figure 2b). Even if an evolutionary "trial and error" process were somehow able to get a few pixels correctly wired, the brain would have difficulty knowing that this condition had occurred because of the incredibly small portion of the FOV that is correctly wired. Natural selection would be unable to positively select for those few pixels in subsequent generations because they would effectively contribute nothing as yet to an image that can be discerned. Unless a substantial portion of the FOV of an eye is producing a useable image (i.e., a functional phenotype), there are no selectable features available for evolution's process of natural selection. Without a selectable phenotype, it cannot distinguish between the correct and incorrect pixel wirings.

Examining a Real Human Eye and Two Eyes with Stereopsis

The problems associated with getting an image in the fovea to be useful are small compared to getting the entire FOV of an eye wired correctly. The immensity of a number such as 15,000! for the fovea becomes additionally incomprehensible when one tries mentally to wrestle with 126,000,000!. Since evolution cannot work to achieve any long-range goal, it can only randomly pick combinations in a "trial and error" process. However, with only such a process available, how can evolution not only correctly wire one eye to the brain correctly, but also get a second eye to match exactly that specified pattern for the first eye? Even if one wants to argue about the definition of "exactly" in the matching process, Figures 6 and 7 show that one can accept a universe full of errors in the matching of the two eyes and still not have a functional pairing of the two FOVs.

A second eye would contend with the same difficulties facing the origin of the first eye. Fusing two images into a combined stereo-pair places an additional burden of being mapped together. The process has already been depicted in Figure 3, but now the pairing of the capital to lowercase blocks represents a left eye to right eye mapping. As poor as the chances were previously for obtaining a useful image in one eye, the probability of two FOVs being mapped together correctly by any evolutionary process is even more troublesome.

There would not appear to be much of a tolerance for errors in these mapping processes either. For a single eye, the vernier acuity (Smith, 1990) of an observer is perhaps 5–10 times finer than the already high-quality foveal FOV resolution. Vernier acuity is the ability to align two objects, such as two straight lines next to each other in the FOV. Almost no "distortion" or image-mapping errors occur in this small central part of the retinal image, compared to what could be expected from randomly connecting the cones to the brain. When a normal observer uses both eyes for detailed observations, the mapping overlap of the two FOV's appears to be continuous, again with no obvious and substantial mapping errors.

As another example of how random chance fails to produce complexity, Thompson (1990) presented the "monkeys typing all the books in the British Museum" statement of Huxley and concluded that this is nonsense. The interesting part of Thompson's answer about reversing the question and asking how many words could actually be produced by the monkeys, leads to another remarkable find. If one replaces Huxley's six monkeys with all the atoms in a 30 millimeter ball bearing (lots of atoms) and each atom "types" at the speed of light for 20 billion years, there are less than 40 specified characters that result from all that effort. But the astounding part is that if we expand the problem to include the entire size of the supposed evolutionary universe (20 billion light-year radius, e.g.) and fill it with atomic computers, we get less than *three times* the number of characters produced by the 30 millimeter ball bearing. Adding more time and space to random-chance scenarios does virtually nothing to help the probabilities.

One just does not have the time or the population base in "evolutionary history" to produce any kind of complex functioning visual system based on random processes. Only a Creator could impart the information needed to provide meaningful sight, and that information would need to be available from the beginning, not acquired randomly by trial and error.

Other Considerations

Some readers could be concerned with my premise that a "unique wiring" is required as part of the specified complexity that defines the eye-brain visual system. Experiments have been conducted where patients have worn inverting eyeglasses, and after a lengthy period the brain was able to re-interpret the imagery as being right side up. But, just because the human visual system has the built-in complexity to be able to rewire itself does not negate the premise of this paper. Rather, it simply relocates the problem to the programming inherent in our DNA, wherein the visual system is capable of establishing or restoring imagery through a yet unknown process. This unknown process is absolutely not random because the visual system does not have enough time to search randomly through all the possible combinations. Rather, that additional complexity has been built into the programming of the visual system such that it can overcome major obstacles with relative ease, despite the fact that we may never know exactly how it is done. Such rewiring experiments are forced to use FOVs that are simple transpositions of the original FOV, such as an image inversion. If, however, the FOV is allowed to be randomly scrambled, such as the situation shown in Figure 2b, the correct imagery would never be restored. It appears that God provided for the normal situation of an optical scene (or its inversion) on the retina to be mapped correctly with the code in our DNA, but did not design this process to be accounted for through random wiring connections. On the other hand, evolution requires random scenarios, and if evolution were true, it would seemingly be able to work with virtually any random-wiring assortment of the visual system. Since that certainly is not the case, the facts point once again to a Creator who established the process. So, how likely is it that the incredibly complex visual system of any sighted creature would develop from very simple eyes by chance-based evolution alone?

Some might point out that symmetry could exist in some of the cases shown in Figure 5, which could possibly change the statistics calculated in subsequent figures. In the case of two pixels, for example, the two possible ways of wiring the pixels either make a correct image, or an inverted one. The brain could probably work with either of these two scenarios and obtain a "good" image simply by inverting the one with upside-down wiring.

In the case of 9 pixels (3 by 3), the inverted-image symmetry case would exist, but there could be diagonal symmetry too. Thus, there could be rotational symmetry in the pixels, which might improve the chances for a good image to be perceived by the visual system. For the case of the 9 pixels in a 3 by 3 matrix, it could be argued that there are actually 8 possible rotations of the image that could be useful, instead of the one case of "perfect" imagery. However, for 9 pixels, there are 9! = 362,880 permutations of the image, and including the other cases of symmetry affects the statistical results only by 0.002%. While such cases of symmetry could be useful for a single eye, in the case of two eyes, all symmetry considerations are obviated. For stereovision, only a single orientation for the left-right images will work.

It could be argued that long ago a single-pixel eye and brain first worked to sense light and movement, and over the evolutionary eons all that mutations did was to add more and more pixels to the working eye. As shown earlier, for even a "trivial" 12-pixel eye there are almost 500 million possible ways to connect the pixels. In a world of "trial and error" processes, how do random mutations work to produce only the good combinations of connections and ultimately eliminate the bad ones? Even if chance could connect 3 of the 12 pixels correctly, in trying to get the fourth connection how does a mutation-driven process isolate the 3 correct pixels from subsequent variations? If evolution "mixes up" the wiring of what once was a well functioning eye into something less functional, what is the basis to suggest that the original functionality can be returned by random mutation alone?

Summary

The image-forming and image-processing capabilities of sighted living creatures are uniquely specified by the simplest laws of optics: the perceived image of an object scene must be a faithful mapping in order for the imagery to be useful and advantageous to the creature. When a retinal image is sampled and transmitted to the brain, a unique "wiring" needs to be established not unlike that used for digital cameras. If this wiring process were performed randomly, even the simplest of sampled images would have an exponential number of possible connections from the actual image to its perceived or displayed counterpart. A surprising result from calculating the various permutations is that 99.9% of all the random attempts to correctly connect the first six pixels of the FOV are in error no matter how many pixels define the FOV. For a FOV the size of the human fovea (15,000 pixels), the conclusion is that 99.9% of the $10^{56,129}$ possible permutations for connecting this small part of the human FOV result in fewer than six pixels being correctly connected.

The mapping process for stereo-imagery from two eyes yields identical conclusions when the visual system attempts to correlate FOV's from each eye. The specificity of the neural network necessary for image formation/interpretation in any eye or pair of eyes cannot be explained by purposeless, undirected, evolutionary processes. Only a designing creator can create the visual systems capable of seeing and interpreting the information contained in the light that He created. Today's scientific research on visual systems shows that we are fearfully and wonderfully made.

Acknowledgement

The author wishes to thank Scott Daniels (University of Minnesota, Duluth) for deriving the recursion relationship given in Appendix 2, which extends the range of values given by Figure 6 to any desired level.

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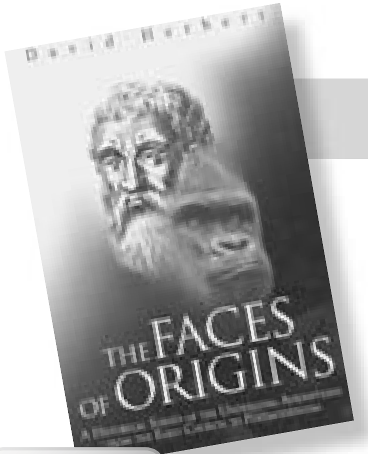
Appendix 1

The reader might be curious why an upper limit 11-pixel case is shown in Figures 6 and 7. To calculate the number of combinations that fell into each grouping M (0 to 11), the author wrote a computer program that searched all the possibilities one at a time. The almost 40 million combinations for 11 pixels (11!) took a 1GHz computer over three hours to calculate. Statistically, by 11 pixels, the trend in the data had sufficiently emerged and no higher values of N (>11) required the brute-force search.

Appendix 2

A recursion relationship exists for the values presented in Figure 6, as well as for additional values of N higher than N=11: $F(N, M) = (N/M)*F(N-1, M-1)$, where for the row of M = 0 the values are given by the Recontres Sequence: $F(N, 0) = (N!/e) + 0.5$, rounded to the next lowest integer, where $e = 2.71828\ldots$ the base of the natural logarithms, and for the matrix locations $F(N, M=N) = 1$ and $F(N, M=N-1) = 0$. The accuracy of the values of F(N, M) is only limited by the precision of the numbers involved.



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Book Review

The Faces of Origins: A Historical Survey of the Underlying Assumptions from the Early Church to Postmodernism

by David Herbert

D & I Herbert Publishing, London, Ontario, Canada, 2004,
138 pages, $10.00.

Here is a book that grabbed my attention immediately, and I easily read it in a few hours. But it is a work to which I will refer in the future for its concise presentation of a large spectrum of individuals and events which have served to mold patters of human thought and behavior. The book is packed with scholarship, having more than 400 footnotes. They are real footnotes, not the usual endnotes to which you have to keep flipping to locate sources.

Faces has many figures showing the various personalities discussed. Other illustrative material includes tables, charts, and line drawings. There is a five-page Selected Bibliography and two-page Index. To me the faces on the front cover are captivating.

The Forward was written by well known author Cornelius G. Hunter who concisely expresses the essence of the book by saying that Herbert exposes "the metaphysics inherent in naturalism in general, and in evolutionism in particular" (p. viii). In other words a naturalistic "religious" worldview was prominent in the development of many modern sciences.

Author David Herbert, an Ontario Canada resident, received his higher education in both Canada and U.S. His field is history which he taught at the secondary school level before retirement. He is the author of two earlier books: *Charles Darwin's Religious Views* (1990) and *The Key to Understanding Origins* (1993). He is a very serious scholar, but like all authors he has his own worldview. In the Preface he says, "This book is written from a bias in which the Bible is viewed as the inspired, inerrant Word of the Living God" (p. xvi). However in reading *The Faces* I had the distinct impression that Herbert was endeavoring to be perceptive and absolutely objective in his evaluation of history.

Herbert begins his journey through history by examining the Church Fathers and assumptions they held in their belief systems. First is the Patristic Period (A.D. 100–476). During this time most of the early Church Fathers (11 of 14 who mentioned the topic) believed that the six Genesis days of Creation were each 24 hours. Augustine (354–430) did not accept the majority view; but his position had been established mainly based on a mistranslation of what later became apocryphal literature, namely Ecclesiasticus 18:1. Underlying assumptions or foundations for the Patristic Period were that God Eternal was the Master Designer, fixity of kinds of life, a global flood, and mankind created in the Image of God. During the Patristic Period the "foundation was formulated."

Following the Patristic Period came the Middle Ages (476–1453) with the crusades, Aquinas, and renaissance with the printing press, etc. During this span of time the previous "foundation was maintained." It also was maintained through the Early Modern Era (1453–1650). Various scholars at work during the Early Modern Era included Martin Luther, John Calvin, and Sir Walter Raleigh.

But during the Modern Era (1650–1800) there was a "new foundation developing." This was the so called Enlightenment or Age of Reason when the roots of the 21st century "secular value system" appeared. Descartes, Voltaire, Diderot, and Paine were active during this period. A French diplomat, Benoit de Maillet, "was the first to propose a purely naturalistic view to the question: Where did we come from?" Also, he "was possibly the first person to publicly advocate a long age for the earth" (p. 75).

Within a somewhat later portion of the Modern Era we find the "foundation altered." Charles Lyell (1797–1875), an English lawyer turned geologist, strongly supported long ages for the earth and life; yet he did favor the idea of creative intelligence, but Lyell, a deist, was at war with Mosaic geology. He detested the harmonization of the Bible and [his own] uniformitarianism. It was a great victory in his mind when the biblical heritage was destroyed and a uniformitarian geology was no longer subject to [a Noachian Flood] (p. 90).

Charles Darwin (1812–1882) became a disciple of Lyell, but he moved even farther away from Christian "foundational" views. The years between 1837–1839 were critical ones for Darwin. It was during this period that he completely abandoned any belief in biblical supernaturalism. His commitment to a naturalistic worldview is seen in a series of six small notebooks (p. 95). In his "Foundation Altered" chapter Herbert sums up the paradigm shift from 1800–1980 with a diagram (p. 116) showing a gigantic shift from biblical supernatural creationary view to naturalistic evolutionism.

Even though there has been a long historical trend toward evolutionary naturalism, it generally is recognized today that this paradigm reached its pinnacle in about 1960, just after the Darwinian centennial in 1959. Around 1961 the tide began to turn, and creationists established a new initiative including surprisingly winning debates against evolutionists. Soon the Creation Research Society was originated, and more than one hundred other creationist organizations sprang up all over the U.S. in addition to others on different continents. The movement is still expanding. In 1981 there was a famous Little Rock, Arkansas, trial (not mentioned by Herbert), and creation books from childhood levels to top scholarship have been rolling of the presses.

In *The Faces* Herbert does refer (in most cases quite briefly) to some of the recent important latter-twentieth-century anti-evolutionary and creation authors: Nancy Pearcy, Phillip Johnson, Tom Woodward, Michael Denton, Neil Broom, Michael Behe, and Henry Morris. A few others not mentioned include Frank Marsh, Duane Gish, George Howe, P.W. Davis, William Dembski (leader of the Intelligent Design movement), Kurt Wise (a leader in baraminology or creationary taxonomy), Jonathan Wells, and Benjamin Wiker. But perhaps events of the last few decades could be covered in another volume. In the meantime *The Faces of Origins* is an excellent book worthy of the attention of those concerned about origins and the history of how scientific and societal beliefs have changed.

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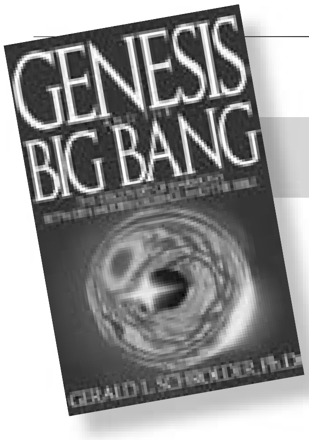

Book Review

Genesis and the Big Bang

by Gerald L. Schroeder

Bantam Books, New York, 1990, 212 pages, $10.00.

From the Introduction, which contains a first-hand report of a 1961 underground test of an atomic bomb in Nevada, to the Epilog which affirms "that the biblical calendar is dated from the appearance of Adam, and not from the creation of the world," (p. 176) the author's exceptional writing skill provides good reading for those who disagree with his treatment, as well as for readers who applaud the conclusions. As a physicist with a doctorate from MIT, and a devout Hebrew scholar who now resides in Jerusalem, Schroeder is preeminently qualified to provide a substantive treatment of tension between scientific speculation and interpretation of biblical specifications regarding the history of the universe.

For readers who want a readily understandable summary of the considerations that gave rise to the Big Bang hypothesis, and of the observations that support its general acceptance beyond mere hypothesis, this book is a valuable resource. Schroeder combines confidence in Big Bang cosmology with implicit acceptance of the Torah as trustworthy from God. To accomplish this he proposes that "the time period from 'the beginning' to the appearance of mankind did take six days and 15 billion years, simultaneously, starting at the same instant and finishing at the same instant" (p. 29). "For the Creator and the created, the union of frames of reference occurred when mankind, represented by Adam and

Eve, absorbed the image of God, some 5700 years ago" (p. 157). To justify such diverse yet simultaneous frames of reference, Schroeder appeals "to Einstein's law of relativity [according to which] it is impossible in an expanding universe to describe the elapsed time during a sequence of events in one part of the universe in a way that will be equal to the elapsed time for those same events when viewed from another part of the universe" (p. 50).

Schroeder's treatment also combines implicit confidence in the testimony of the first two chapters of Genesis with full confidence in the current uniformitarian view regarding the geological column and its associated fossils. Such combination requires "the date when an organism appears in both the fossil record and the biblical account [to correspond with] the complexity of that organism" (p. 128). The author's effort to place the plant life of Day Three lower on the evolutionary scale then the marine life on the ocean floor (Day Five) gave me appreciation for his commitment to the Torah as the reliable Word of God, and also strengthened my conviction that the current uniformitarian evolutionistic hypotheses and the Word are irreconcilable.

The implications of the miracles reported in the New Testament (viz., Jesus' replacement of an arm palsied from birth, resurrection of Lazarus, and two occasions of feeding between 4000 and 15,000 people) at least makes unessential the speculation that "A one-time phenomenon [Big Bang] occurred that started the … universe on its life-directed course" [and] "fixed for all time the amounts of matter and antimatter in the universe" (p. 155). Would it have been necessary to utilize billions-of-years old atoms in these mini-creations?

A major contribution of *Genesis and the Big Bang* is the references which establish that centuries before the development of modern science, Jewish scribes had proposed a basic creation event vastly prior to the Creation Week specified in Genesis. "Biblical traditions and current cosmology [are] two systems of thought that have developed independently" (p. 161. See also pp. 18 and 149).

This book contains many positive contributions such as the following from p. 25: "The answers provided by science for life's origins are no more satisfying than those provided for the universe's origins.… There is now overwhelmingly strong evidence, both statistical and paleontological, that life could not have been started on Earth by a series of random chemical reactions.… [T]he fossil record [fails] to confirm Darwin's (or any other) theory of gradual evolution." On p. 111 we read that "The likelihood of random processes producing life from a primordial bath of chemicals is even less likely than that of your shaking an omelet and having the yolk and the white separate back into the original form of the egg!"

In the first chapter the author states that "it is impossible to disprove the idea that patterns of radioactive decay have changed during the past few thousand years" (p. 15). A subsequent discussion on the nature of the physical universe (Ch. 5) contains the following observations: "The recurring patterns of the chemical and physical reactions that we observe on a large scale are the results of forces operating at the level of the elementary particles. These forces appear as fixed and inherent properties of the substance from which all the universe is constructed. It also appears that these properties have been a part of the universe at least for billions of years and probably since its creation. We surmise this from the fact that the spectral properties of light received from galaxies billions of light years distance are the same as spectra of light originating in our solar system and galaxy.… The similarity among spectra implies that the nuclear, atomic, and molecular structure of our part of the universe is extant throughout the universe" (pp. 85, 86).

In concluding this review I would like to make a plea that attempts to harmonize scientific observation with the specifications in Gen. 1:1–2:4a be limited to the definition of key terms given by God Himself in 1:8–10, and not based on additions to the designations of those terms that developed centuries after Moses wrote the Torah. Would God inspire Moses to write a text that for over 3000 years conveyed an incorrect meaning of the term for *day*?

The last chapter of *Genesis and the Big Bang* expanded my insight that God's character may be perceived, and our highest concern is to understand it. But His nature is beyond human capability for understanding. This book also was reviewed earlier in the *CRSQ* (Chaffin, 1996).

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A Critique of Progressive Creationism in the Writings of Hugh Ross

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Abstract

Naturalistic evolutionism, theistic evolutionism, progressive creationism, and the day-age theory are briefly defined, contrasted, and discussed. Two major books of a contemporary progressive creationist, Hugh Ross, are analyzed and compared. Nine of his corollaries are examined, and any that have already been refuted by other authors are treated briefly. Recent developments in his progressive creationism, and claims that have not yet been countered, are examined more extensively.

Introduction

Naturalistic evolution is the concept that the cosmos and life originated and developed by natural means alone. *Theistic evolution* is the teaching that God originated and controlled evolution. *Progressive creationism* (PC) is the position that God periodically overruled evolution by miraculously creating new forms, which then underwent evolutionary changes. The day-age theorists (DATists) believe that the "days" of creation (Genesis 1) are really six long ages.

In the mid-twentieth century Ramm (1954) popularized the practice of calling evolutionism "creation" as long as it was recognized that the process was controlled by God rather than by chance alone. He was one of the early and influential progressive creationists (PCists). Hugh Ross (1994, 2004) has continued promoting PC and has identified himself with "old earth creationists" and as having an "old earth position" (Ross, 2004).

The theses of Ross have changed very little in the decade between 1994 and 2004, so that his latest book (Ross, 2004) reads in places like the earlier one (Ross, 1994). For example, page 19 of his book *A Matter of Days* (Ross, 2004) is virtually identical to page 10 of the 1994 book, *Creation and Time*. Ross's earlier book was critically analyzed by several authors (e.g., Van Bebber and Taylor, 1994; Sarfati, 2004). Points previously criticized will be listed and discussed in brevity and in the context of his *Creation and Time*. Salient revisions, changes, or new theses included in the book, *A Matter of Days* (Ross, 2004) will be analyzed more extensively. The purpose here is not to evaluate the Christian faith of Ross but to identify the errors in biblical scholarship found in his writings.

Ross has been generally regarded as a leading contemporary spokesman among the PCists. Like other PCists, Ross is also a DATist (1994) and equates the day-age theory (DAT) with progressive creationism (1994). His arguments for the DAT are essentially the same as those used by other PCists to buttress their views.

Analysis of Ross's Arguments

PCists Assert That Creation Should Include Long Ages

Ross acknowledged that "the word *creationist* implies the young-universe position" but then sought to widen the meaning of creation with the comment that "many orthodox Christians who believe in creation (and deny Darwinism) hold different views regarding the timing of creation" (Ross, 2004, p. 11). Ross's claims amount to saying that only atheists should be considered evolutionists, and he expressed explicitly his belief that the universe is very old: "God created as He did, for billions of years" (Ross, 1994, p. 68). Although having expressed belief in the

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direct creation of Adam and Eve from dust, Ross wrote that God "stepped in many times to create replacements or improved models—sometimes completely abandoning entire groups of animals, changing the previous course of life on earth" (Van Bebber and Taylor, 1994, p. 11). Ross asserts that "the whole cosmos was assembled step-by-step over billions of years" (Ross, 1994, p. 137), that "3.8 billion years of plant and animal death and extinction ... preceded humanity" (Ross, 2004, p. 103), and that "the earth and the universe are several billion years old" (Ross, 2004, p. 213).

In short, under the name of creation, Ross has encouraged church people to embrace long ages and limited evolutionism.

Progressive Creationists Teach That Genesis 1 Describes Evolution

To set the stage for this claim, Ross (1994) maintained that

> In its ordinary usage among scientists and non-scientists alike, especially among physical scientists, *evolution* simply means 'change with respect to time' ... The time can be short or long. The change can be small or great and more or less gradual. The cause can be intelligent or nonintelligent (p. 74).

Such a definition of evolution is disingenuous at best. Wells (2000) observed:

> When proponents of [evolution] are responding to critics, they sometimes claim that 'evolution' means simply change over time. But this is clearly an evasion. No rational person denies the reality of change, and we did not need Charles Darwin to convince us of it. If 'evolution' meant only this, it would be utterly uncontroversial (p. 5)

Physical scientists, including astronomers, view evolution not just as any change, but as an upward change in complexity (Henry, 2003a). Nevertheless, building on his fallacious definition of evolution, Ross (1994) concluded, "By this definition, we could say that Genesis 1 describes evolution, for it describes change in the realm of nature" (p. 74). Thus Ross redefined evolution in such a way as to force Genesis 1 into an evolutionary framework.

Progressive Creationists Claim That *Yom* in Genesis 1 Is a Long Time Period

"The Hebrew word *yom*, translated *day*, may be used (and is) in biblical Hebrew, as it is in modern English, to indicate ... a segment of time without any reference to solar days (anywhere from weeks to a year to several years to an age or epoch)" (Ross, 1994, p. 46). Then several references follow in which Ross claimed *yom* to have been used non-literally in Genesis (Ross, 2004, pp. 73–75). Ross's claim of non-literality, however, does not apply to the context of *yom* in Genesis 1. James Barr of Oxford University has written:

> Probably, so far as I know there is no professor of Hebrew or Old Testament at any world-class university who does not believe that the writer(s) of Genesis 1 through 11 intended to convey to their readers the ideas that (a) creation took place in a series of six days which were the same as the days of 24 hours we now experience; (b) the figures contained in the Genesis genealogies provided by simple addition a chronology from the beginning of the world (Barr, 1985. Personal communication to D.C.C. Watson, quoted in Morris, 1999, p. 31).

A straightforward reading of Genesis 1 communicates a literal six-day sequence, a fact acknowledged even by Pattle Pun, a biologist and PCist at Wheaton College:

> It is apparent that the most straightforward understanding of the Genesis record ... is that God created heaven and earth in six solar days, that man was created in the sixth day, that death and chaos entered the world after the Fall of Adam and Eve, that all of the fossils were the result of the catastrophic universal deluge which spared only Noah's family and the animals therewith (Pun, 1987, p. 14).

Does Pun believe this? Unfortunately, no, for this quotation omits the qualifier that in Pun's view negated the obvious reading of Genesis; the obvious reading is not valid "without regard to all the hermeneutical considerations suggested by science" (Pun, 1987, p. 14). In spite of these statements by Barr and by Pun, Ross claimed that:

> Young-earth creationists have argued for twenty-four-hour days on the basis that *yom* when attached to an ordinal (second, third, fourth, etc.) always refers to a twenty-four-hour period. This argument can be challenged on several grounds. For one, it is true only for passages describing days of human activity rather than days of divine activity (Ross, 1994, pp. 46–47).

This is a statement for which Ross gave no documentation. "More important, the rules of Hebrew grammar do not require that *yom* must refer to twenty-four hours, even when attached to an ordinal" (Ross, 2004, p. 74). This is misleading because it is hermeneutics, not "grammar," that would make such a requirement. Hermeneutics, applied to the context of Genesis 1, show that Ross's claims are false and the distinction between human and divine activity is linguistically irrelevant.

In the Hebrew, day one of creation is not preceded by an ordinal number; "first day" as rendered in English translations is literally "one day" in Hebrew. Steinmann (2002) pointed out that this Hebrew construction signifies that day one of creation was a literal day as we commonly understand it: "Gen. 1:5 begins the cycle of the day. With the creation of light it is now possible to have a cycle of light and darkness ... Hence the following equation is what Genesis 1:5 expresses: Evening + morning = one day" (p. 583). The "one day" construction of Genesis 1:5 also appears in Zechariah 14:7, which refers to the "day of the Lord." Ross (2004) attempted to rebut Steinmann's conclusion by asserting that the "day of the Lord" is "a time period longer than 24 hours" (p. 75). In the context of Zechariah 14:4, however, this day is one in which the Lord returns, an event occurring in a moment, not a long period of time. Use of the "one day" construction in Zechariah 14:7 actually strengthens Steinmann's conclusion.

Howitt (1953) wrote to nine leading universities asking credentialed professors:

> Do you consider [that] the Hebrew word 'Yom' (day) as used in Genesis 1 accompanied by a numeral should properly be translated (a) a day, as commonly understood, (b) an age, (c) either an age or a day without preference? (p. 15).

Professors at Columbia, Harvard, London, Manitoba, McGill, Toronto, and even Yale answered that in Genesis 1 *yom* is a day as commonly understood. Robert H. Pfeiffer of Harvard explicitly specified the days in Genesis 1 as twenty-four hours long (Howitt, 1953). Only faculty from Oxford and Cambridge did not respond to Howitt's question. As mentioned previously, however, Barr of Oxford affirmed that "day" in Genesis 1 was meant to signify twenty-four hours.

It is no wonder, therefore, that even DATist Davis Young acknowledged that "the exegetical arguments for the twenty-four-hour-day hypothesis also have support in Scripture," though he admitted he was disinclined to accept "that hypothesis" (Young, 1982, p. 160). Earlier he gave the reason for his disinclination as follows: "Christians who believe that the Earth is very ancient are generally persuaded by scientific arguments that such is the case" (Young, 1982, p. 14). In other words, the Bible speaks clearly for itself, but "science" added to the Bible demands a different message than the one intended by God.

Another argument against literal days in Genesis 1 is that the seventh day still continues. Ross (1994) claimed that:

> Of the first six creation days Moses wrote, 'There was evening, and there was morning—the Xth day.' This wording indicates that each of the first six creation days had a beginning and an ending. However, no such wording is attached to the seventh creation day, neither in Genesis 1–2 nor anywhere else in the Bible. Given the parallel structure marking the creation days, this distinct change in form for the seventh day strongly suggests that this day has (or had) not ended. ... We gather that the seventh day of Genesis 1–2 represents a minimum of several thousand years and a maximum that is open ended (but finite). It seems reasonable to conclude, then, given the parallelism of the Genesis account, that the first six days may also have been long time periods (p. 48–49).

More recently, Ross (2004) made a similar statement (see pp. 83, 94). The "parallel structure" of the days, to which Ross alluded above, is a feature of the "framework hypothesis," which originated with Arie Noordtzij in 1924 (Young, 1964). The framework hypothesis views Genesis 1 not as a literal historical account, but as a "theology of the Sabbath" in which days 1, 2, and 3 are parallel to days 4, 5, and 6 (Blocher, 1984, p. 51). The seventh day therefore stands alone and is unlike the other days. The framework hypothesis fails when subjected to contextual analysis as in Steinmann (2002, p. 584), who affirmed that the seventh day, and the other days of creation, were "regular solar days." Additional PCist arguments for a continuing seventh day will be analyzed below. Ross further avowed that:

> Old-earth creationists [have found] many scriptural reasons, apart from science, for interpreting the creation days as long periods. [The first of these reasons is as follows.] 1. The length of God's days. The same author of Genesis (Moses) wrote in Psalm 90:4, 'For a thousand years in your sight are like a day that has just gone by, or like a watch (four hours) in the night.' Moses seems to state that just as God's ways are not our ways (Isaiah 55:9), God's days are not our days (Ross, 1994, p. 46; brackets added).

This statement is unwarranted, however, because the Hebrew construction of Genesis 1 does not permit the extension of the meaning of "day" in Psalm 90:4 to the specific context of Genesis 1. Carson (1996) described this fallacy as the "unwarranted adoption of an expanded semantic field," (p. 60) by which he was referring to the illegitimate practice of forcing all the possible meanings of a word into a context that demands a specific meaning. Ross has committed this error repeatedly. Peter's allusion to Psalm 90:4 in 2 Peter 3:8 is likewise exploited to argue non-literal creation days. The context of 2 Peter 3:8, however, does not concern chronology but events preceding the return of the Lord. Thus, there is every reason to hold that the days in Genesis 1 are literal, not figurative.

PCists Claim That Too Much Happened on Day Six for It to Be Literal

On day six, God did too much work for one literal day, including the following according to Ross (2004, p. 80):

> (1) "God planted a garden in Eden."
>
> (2) Adam received "instructions from God" about caring for the Garden.
>
> (3) Adam "worked and cared for the Garden of Eden."
>
> (4) Adam "carried out his assignment from God to name all the animals."
>
> (5) "God put Adam into a deep sleep [and] performed an operation" to create Eve, after which Adam exclaimed "now at length" he had found a help meet for him.
>
> (6) Adam "[learned] how to relate to Eve."
>
> (7) "Adam and Eve [received] instructions from God for managing plants, animals, and other of Earth's resources."
>
> (8) "Adam and Eve learned how to manage Earth's resources."
>
> (9) Fischer (2003, p. 224) claimed that on day six in addition to the above events there had to be time in which "the garden grew and matured to the extent that the seed which God planted became trees bearing edible fruit." [Material in quotes is from Ross, 2004, p. 80. Materials not in quotes and material in brackets are added.]

Besides Ross, other PCists and DATists have claimed that naming the animals was a very lengthy process. According to Fischer (2003, p. 224), this included "all the world's thousands and thousands of animal species," and according to Archer (1982, p. 60), this task "must have taken a good deal of study for Adam to examine each specimen and decide on an appropriate name." In the PC view, each day six event was extremely time consuming. Fischer (2003, p. 224) claimed that the language of Genesis 2:23 implies that Adam was introduced to Eve only "after a long wait or lengthy search." Ross (2004, p. 80) claimed that day six must have covered "many weeks', months', or even years' worth of activities." Archer (1982, p. 60) concurred that just the "comprehensive inventory of all the birds, beasts, and insects that populated the Garden of Eden" would have required "some years, or, at the very least, a considerable number of months."

If the best that Ross and others can do is to stretch day six into a few months or even a few years, this is hardly warrant for expanding day six or any creation day any further into millions of years of geologic ages as Ross (2004) did elsewhere. Even Ross's and Archer's expanded day six leaves no room for conventional chronology. The demand for excessive time to fulfill each of the nine events listed on day six above is faulty, as we will now see by examining each one of the day six events.

Event #1. When God "planted a garden" (Genesis 2:8), He did so by instantaneous fiat as with nearly every other action in the Creation Week. The only Divine acts of creation that were not done by instantaneous fiat were the creation of Adam from the "dust of the ground" (Genesis 2:7), and the creation of Eve from Adam's rib (Genesis 2:21–22). But even these two were done rapidly—within one real day.

Event #2. The Bible does not say that God gave Adam instructions about caring for the Garden; Genesis 2:15 says instead that God "put him into the garden of Eden to dress it and keep it." This is not an action that would take hours, days, or weeks, or longer.

Event #3. Genesis 2:15 states merely that Adam was supposed to dress and keep the Garden of Eden, not that he actually did so on day six. Thus work and care for the Garden occupied no time on day six.

Event #4. Adam did not name all the animals, only cattle, fowl, and beasts (Genesis 2:20). He did not name insects, as Archer claimed, or marine creatures. The claim that Adam named all the animals and that such a task would have demanded a far longer time than one day has been carefully and thoroughly refuted by Van Bebber and Taylor (1994, pp. 80–82). The distinction between "kinds," a broad classification of creatures made by creationists, and "species," a much smaller subdivision, is an important concept in Van Bebber and Taylor's argument.

Event #5. To create Eve, God put Adam into a deep sleep, took one of his ribs, closed up Adam's flesh, and made Eve from the rib (Genesis 2:21–22). Even if we suppose that this divine surgery required several hours, we have together with Adam's naming of the animals a span of time typical of an average working day. On the other hand, all the miracles of healing in Scripture were instantaneous. In the KJV, Adam's exclamation about Eve in Genesis 2:23 is rendered "This *is* now bone of my bones," which suggests immediate sequence. Ross (2004, p. 80) has contended that the rendering should be, "this is now *at length* bone of my bones," implying a long interval between Adam's creation and that of Eve. During day six Adam named the animals, gradually realizing that there was not a "help meet for him" (Genesis 2:18). In II Timothy 2:13 Paul stated, "For Adam was first formed, then (Greek *eita*) Eve." In the New Testament, *eita* signified one action soon following another, a conclusion evident from verses in which *eita* appears, such as John 13:15, 19:26–27, 20:27, Mark 4:15, 8:25, Luke 8:12, and James 1:14–15.

Event #6. Genesis 2:23–25 does

not say that Adam learned "how to relate to Eve" (Ross, 2004, p. 80). Like Event #3 above, this was really a nonevent of day six!

Event #7. God's instructions to Adam and Eve about earth stewardship occupied only three verses of text (Genesis 1:28–30) and would have required only a few minutes.

Event #8. The Bible nowhere says that "Adam and Eve learned how to manage Earth's resources" on day six as Ross (2004) claimed. Indeed, this is an ongoing human activity that continues to this day.

Event #9. Genesis 2:9 says that God made "to grow every tree" in the Garden, but not that trees grew from seed over a period of years. If they needed time to grow from seeds, why does the text imply that God planted trees, not seeds? "Actually there is nothing to suggest that the Hebrew can't simply mean that the trees were created as growing, as long as they were still mature enough to produce seeds" (Sarfati, 2004, p. 89).

Besides inflating the time required for the events of day six, Ross envisioned supposed events that according to the Bible never really happened. The real events of day six occupied a typical working day, and probably less, and so pose no challenge to day six being a literal day. In fact, Van Bebber and Taylor (1994) showed that the "events of Day Six are no problem for young-earth creationists [but] they are virtually impossible for Progressive Creationists" (p. 83–84).

PCists Claim That Day Seven Is Continuing and So Is Not Literal

Ross (2004, p. 81) stated that: "While each of the first six creation days is marked by a beginning ('morning') and an ending ('evening'), no such boundaries are assigned to the seventh creation day, neither in Genesis 1 and 2 nor anywhere else in the Bible." Accordingly, a seventh day that is at least several millennia (and possibly eternal) means that the first six days must also have been long and indefinite intervals (Ross, 1994, 2004; Kline, 1996). But even if day seven could be shown to be extremely long, this "would say absolutely nothing about the length of the other six days" (Thompson, 2000, p. 215), because Ross in his words put day seven in a category separate from the other six days. Van Bebber and Taylor (1994) have extensively refuted Ross's assertion that the seventh day was (and therefore all of the six days were) a long and indefinite period of time.

PCists Claim That Literal Creation Days and Recent Creation Are New Ideas

Ross claimed that until the "scientific age," Christians were led to believe wrongly that there was "general agreement" that the six days of creation were twenty-four-hour days (Ross, 1994, p. 16; Ross, 2004, p. 15). Ross then discussed the views of early scholars, including Philo, Josephus, Irenaeus, Justin Martyr, Hippolytus, Clement of Alexandria, Origen, Lactantius, Victorinus of Pettau, Methodius of Olympus, Eusebius, and Ambrose, and concluded that all were either neutral or in favor of long creation days and possibly long ages (Ross, 1994, 2004).

The claim that early believers held to long days of creation is false. Even DATist Davis Young emphasized repeatedly that:

> Until the end of the eighteenth century, Christians were virtually unanimous in the belief that the Earth was about six thousand years old according to the teaching of Scripture... In general, the church fathers regarded the days of creation as ordinary days corresponding to our existing sun-measured, solar days. ... We find absolutely no one arguing that the world is tens of thousands of years old on the grounds that the six days are used figuratively for indefinite periods of time. ... Many of the church fathers plainly regarded the six days as ordinary days. Basil explicitly spoke of the day as a twenty-four-hour period. ... It cannot be denied, in spite of frequent interpretations of Genesis 1 that departed from the rigidly literal, that the almost universal view of the Christian world until the eighteenth century was that the Earth was only a few thousand years old (Young, 1982, pp. 13, 20, 22, 25).

Van Bebber and Taylor (1994) discussed the views of these early church leaders extensively and proved that they did not support long ages (see p. 73–100).

PCists Claim That "Recent Creation" Is Poor Scholarship

In 1642 John Lightfoot published a chronology putting creation at 3928 BC. James Ussher followed in 1650 with a chronology having 4004 BC for the date of creation (Ussher, 1658). Ussher's creation date was widely accepted for the next two centuries. The claim that Lightfoot and Ussher practiced poor scholarship has been debunked extensively in Van Bebber and Taylor (1994).

Besides Ross's (1994, 2004) challenge to the scholarship of Lightfoot and Ussher, Ross charged that the genealogies in Genesis 5 and 11 are "not as tight as it may appear at first glance," that there is "at least one gap," and that "others might exist" (Ross, 2004, p. 223). Ross (2004, pp. 22, 224) concluded that the possibility of genealogical gaps shows that Adam and Eve were created "sometime between 10,000 and 60,000 years ago." However, the existence of genealogical gaps is "inconsequential" because at most, the years added to chronology by genealogical gaps would be "only about

0.0001 percent [of] the range of dates affirmed by science [i.e., evolution]" (Ross, 2004, p. 22). Though correct in claiming the gaps inconsequential relative to conventional chronology, Ross contradicted himself because in both his books (Ross, 1994, 2004) he calls the Lightfoot/Ussher chronologies into question before beginning his other arguments for the PC position, a position that involves a giga-year cosmic chronology.

Arthur Custance was one of the strongest modern proponents of the gap theory, sometimes called the "ruin-reconstruction theory." The gap theory claims that an indefinite gap of time existed between Genesis 1:1 and Genesis 1:2. Custance would appear to have been open to finding gaps in the Genesis genealogies, but he could not:

> We are told again and again that some of these genealogies contain gaps: but what is never pointed out by those who lay the emphasis on these gaps is that they only know of the existence of these gaps because the Bible elsewhere fills them in. How otherwise could one know of them? But if they are filled in, they are not gaps at all! Thus, in the final analysis the argument is completely without foundation (Custance, 1967, p. 3).

Further, "even if there were gaps in the genealogies, there would not necessarily be gaps in the chronologies therein recorded. The issue of chronology is not the same as that of genealogy" (Thompson, 2000, p. 249). Jordan elaborated:

> Gaps in genealogies, however, do not prove gaps in chronologies. The known gaps all occur in non-chronological genealogies. Moreover, even if there were gaps in the genealogies of Gen. 5 and 11, this would not affect the chronological information therein recorded, for even if Enosh were the great-grandson of Seth, it would still be the case that Seth was 105 years old when Enosh was born, according to a simple reading of the text. Thus, genealogy and chronology are distinct problems with distinct characteristics. They ought not to be confused (Jordan, 1979, p. 12).

Ross claimed that:

> Lightfoot [had] made an adjustment to Ussher's date ... [concluding] that all creation took place during the week of October 18–24, 4004 BC, with the creation of Adam occurring on October 23 at 9:00 a.m., forty-fifth meridian time (Ross, 1994, p. 26; Ross, 2004, p. 22).

Ross (1994) correctly points out, "This extraordinarily precise conclusion has provoked some mirth among both Bible scholars and critics" (p. 26). The precise timing of creation, however, was a fabrication invented by anti-creationist Andrew D. White, first president of Cornell University, in order to ridicule the Ussher chronology (Klotz, 1987, pp. 173–174). Following up on the fabricated Lightfoot story, Ross attempted to assert that the modern age debate is the product of the foolish dogmatism of Ussher and Lightfoot. In doing so, he traced the scenario of the rise of secularism, which, unintentionally, shows how the debate really came about as a battle between belief and unbelief (Ross, 1994).

Ross would seem overconfident of his claim that "science" has disproved Ussher. Some secular scientists give credence to the Ussher chronology that Ross rejects. Solar expert John Eddy, for example, stated:

> I suspect that the Sun *is* 4.5-billion years old. However, given some new and unexpected results to the contrary, and some time for frantic recalculation and theoretical readjustment, I suspect that we could live with Bishop Ussher's value for the age of the Earth and the Sun. I don't think we have much in the way of observational evidence in astronomy to contradict that (as quoted by Kazmann, 1978, p. 18).

As mentioned, Ussher put the date of creation at 4004 BC. According to Eddy, nothing in solar data contradicts this. The only real conflict is between recent creation and evolutionary beliefs, not scientific data. Indeed, there is really no scientific reason that the entire universe could not be viewed as young. Evolutionary cosmologist George Ellis wrote that:

> A modern cosmologist who was also a theologian with strict fundamentalist views could construct a universe model which began 6000 years ago in time and whose edge was at a distance of 6000 light years from the solar system. A benevolent God could easily arrange the creation of the universe…. It would be impossible for any other scientist on the Earth to refute this world picture experimentally or observationally; all that he could do would be to disagree with the author's cosmological premises (Ellis, 1975, p. 246).

Proof of an old universe is lacking and its true age could be 6000 years. Indeed, self-professed atheist astronomer Duncan Steele (2000) noted: "Many disparate civilizations have ... assumed beginnings of time occurring a few thousand years B.C." (pp. 111, 135), and he added specifically, "... within a few centuries of 4000 B.C" (p. 40). Ussher-like dates are therefore biblically warranted and consistent with science. The conflict between biblical chronology and "science" is really a conflict with evolutionary interpretations of scientific data.

PCists Claim That the Age of Creation Is a Trivial Issue

Ross made this assertion repeatedly saying, "The battle line has been drawn over a peripheral point—the age of the universe and of the earth" (Ross, 1994, p. 8; Ross, 2004, p. 15). Yet in 1994 and 2004, Ross wrote two books entirely devoted to the question of age, showing that he really believes that the age question is very important. Ross elsewhere said:

> But misidentifying the timing of God's works in the cosmos has little bearing on [one's relationship with Christ]. Nor does it bear upon the Bible's authority. It appears ill-advised, then, to make an issue out of such a trivial doctrinal point. ... For creationists to make an issue of such a relatively trivial doctrinal point seems both impolitic and unnecessary (Ross, 1994, p. 11).

History reveals that the change from a recent creation view to a long-age creation was not a trivial point. In Western culture, Charles Lyell in the 1830s was the first to convince a large public that the old ages of geology were plausible and real. However, Lyell's private agenda, never revealed publicly during his lifetime, was to overthrow the authority of biblical chronology (Henry, 2003), an agenda that was possibly motivated in part by political issues of the day (Grinnell, 1976).

Much could be written about the influence that a mistaken timing of creation might have on one's relationship with Christ. One such story concerns Harvard entomologist Edward O. Wilson:

> As were many persons from Alabama, I was a born-again Christian. When I was fifteen, I entered the Southern Baptist Church with great fervor and interest in the fundamentalist religion; I left at seventeen when I got to the University of Alabama and heard about evolutionary theory (Wilson, 1982, p. 40).

Philosopher Huston Smith commented in the liberal *Christian Century* that "Martin Ling is probably right in saying that `more cases of loss of religious faith are to be traced to the theory of evolution ... than to anything else" (Smith, 1982, p. 755). While Ross's view is labeled "creationism," it involves long periods of time and major amounts of evolution, which both played a role in Wilson's loss of faith. In later years, Wilson was a major spokesman for the Wildlands Project, a little-publicized agenda calling "for nothing less than resetting the entire [North American] continent" (Mann and Plummer, 1993, p. 1868).

> The Wildlands Project ... calls for a network of wilderness reserves, human buffer zones, and wildlife corridors stretching across huge tracts of land—hundreds of millions of acres, as much as half of the continent. ... On the Oregon coast, for example ... the Wildlands approach calls for 23.4% of the land to be returned to wilderness, and another 26.2% to be severely restricted in terms of human use. Most roads would be closed; some would be ripped out of the landscape. ... Similar alterations are called for in Vermont, Florida, the mid-Atlantic region, and the rest of the country (Mann and Plummer, 1993, p. 1868).

Whether or not the Wildlands Project is implemented as described, project planners have been explicit about the project's neopagan motivation, which "includes a moral and spiritual dimension in addition to a geographic one" (Mann and Plummer, 1993, p. 1870). Considering Wilson's influence, it is legitimate to wonder if the Wildlands Project with its implicit paganism would even exist today if evolution and long-age theories had not turned Wilson away from God half a century ago. History has revealed that the age of creation is not a trivial issue, but is important spiritually and culturally.

PCists Claim That Teaching Long Ages Is Not Harmful to Christian Faith

Ross claimed that, "Interpreting the Genesis creation days as tens of millions or even hundreds of millions of Earth years in no way lends support to evolutionism" of a nontheistic variety (Ross, 1994, p. 80). This claim is revealed as false by the case of Charles Lyell, who advocated long ages precisely to undercut the Bible and support evolution (Henry, 2003b).

Ross further devised a motivation, which he has claimed to be the reason why recent-creationists oppose long ages. This motivation is fear: "The fear expressed by many devout Christians that long creation days greases a slide into the tenets of naturalistic evolution ... or theistic evolution ... has no scientific foundation" (Ross, 1994, p. 80). In other words, according to Ross, this fear is irrational. But history reveals there is danger.

For example, in his seminal work *Studies in Genesis One*, scholar E. J. Young (1964, p. 105) defended the historicity of the first chapter of the Bible. Young, however, had long been enamored with the idea that the creation might be old. In E. J. Young's otherwise excellent book, *Thy Word Is Truth* (1957, pp. 169–170), he said, "The long ages of geology may indeed have occurred . . . We incline toward the view that the days [of creation] were periods of time longer than twenty-four hours. We do this ... upon exegetical grounds." Yet E. J. Young nowhere said what these "exegetical grounds" might have been.

E. J. Young's son, Davis Young, has authored books (e.g., Young, 1982) advocating the non-historicity of Genesis 1 and calling for conformity with modern uniformitarian geology. It is certainly possible that the doubts of the father became rooted in the mind of the son and contributed to his abandonment of a historical Genesis 1. More generally, evolution's own advocates have acknowledged that the rise of modern evolution since the 1800s contributed to the following trends:

- The decline in Christianity in the West (Denton, 1985, p. 66);
- The rise of higher criticism (Powicke, 1955, p. 228);
- The rise of ecumenism (Wendte, 1911, pp. 33–34, 162, 404);
- The appearance of neopaganism (Barrows, 1893, pp. 78, 87, 96, 192–193, 331, 456–457);
- The rise of Communism (Zirkle, 1959, p. 85; Kramer, 1999, pp. x, xix);
- The appearance of Nazism (Kramer, 1999, pp. xi, xix);
- Modern racism (Hsu, 1987, p. 377);
- Global war (Keith, 1947, pp. 28, 230);
- Twentieth-century genocide (Kramer, 1999, p. x).
- A cultural climate favorable to the global rise in abortion and euthanasia (Burke, 1984, p. 29).

One must also remember that long-age theories helped to popularize naturalistic evolutionism.

Naturally, this legacy of evolution is not pleasant material and therefore is not often discussed. Too close a look at the legacy of evolution can tarnish the image of our heroes. Winston Churchill, for example,

> ... was profoundly impressed by Darwinism. He lost whatever religious faith he may have had—through reading Gibbon, he said—and took a particular dislike, for some reason, to the Catholic Church, as well as Christian missions. He became, in his own words, 'a materialist—to the tips of my fingers,' and he fervently upheld the worldview that human life is a struggle for existence, with the outcome the survival of the fittest (Raico, 2001, p. 325–326).

Perhaps this explains why "there *was* one constant in his life: the love of war" (Raico, 2001, p. 325). It is an illusion to believe that the teaching of long evolutionary ages as fact is harmless; it opens the door to evolutionary beliefs, eventually resulting in spiritual and physical harm personally and culturally.

Summary

PCist arguments for long evolutionary "days" of creation and an old creation are not tenable biblically. It is shown here that: (1) the days of creation were literal; (2) Psalm 90:4 and 2 Peter 3:8 do not imply figurative days of creation; (3) the concept of literal creation days is an old teaching, not a new one originating just a couple of centuries ago, as asserted in Ross (2004); (4) early church fathers such as Augustine did not consistently allegorize the days of creation and often taught that they were literal; (5) there are no gaps in biblical genealogies, so the insertion of extra time into the chronology is invalid; (6) the super-precise Ussher/Lightfoot timing of the earth's creation at 9:00 am, October 23, 4004 BC, was a fabrication; and (7) Ussher-like dates for creation are biblically and scientifically warranted.

The Bible is God-breathed and deserves our full attention on every detail, including its remarks about creation. Its clear statements on these issues are more authoritative than scientific theories that replace supernatural, fiat creation with naturalistic origins processes.

Acknowledgement

I thank George Howe for editorial suggestions.

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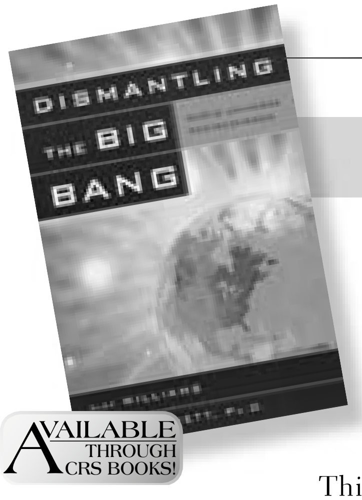

Book Review

Dismantling the Big Bang

by Alex Williams and John Hartnett

Master Books, Green Forest, AR, 2005, 346 pages, $15.00.

This is the first book co-authored by Alex Williams and John Hartnett. Alex Williams has an M.S. degree in botany from Macquarie University in Sydney, Australia and worked for 24 years as a government botanist. He has three certificates in theology and also served as a missionary for seven years. Williams' writing skills have been demonstrated by many articles written for botany journals and *Creation* magazine. His interest in cosmology is personal. John Hartnett received B.S. and Ph.D. degrees from the Department of Physics, University of Western Australia. He is well known for articles in the *Technical Journal* on the topics of astronomy and cosmology. The authors combine to make an overwhelming case for discounting the Big

Bang model as a theory of the origin of the universe. They show there is no known cause for the Big Bang and the effects resulting from this hypothetical event cannot explain the universe we observe today.

The book subtitle is "God's Universe Rediscovered." This is appropriate because the book also contains much material promoting the traditional viewpoint that God created the universe in six days. It compares the Big Bang model to the creation model and finds that the latter is superior in explaining the known universe. The book is well organized with a table of contents, a brief overview, an introduction, eight chapters, an epilogue, four appendices and an index. The first chapter begins with a brief history of cosmology and how the Big Bang model was developed. The second chapter explains the philosophy or worldview driving the development of this model and some of the limitations that science faces when answering questions about the origin of the universe. Chapter three explains the tools scientists use to explain the universe. In chapter four the Big Bang model is described in detail from the beginning as a singularity to the origin of life. Chapter five investigates the time scale the Big Bang model requires and shows that age cannot be measured by extrapolating back present processes because they may have changed and there is no means of verifying the calibration of a measurement process.

Chapter six is devoted to the biblical model of creation. The authors choose the traditional creation model which they call the *thelein* model. In my opinion they do not use the same rigor to defend this model as used earlier to point out the weaknesses in the Big Bang. As an example, the thelein model proposes that God speaks into existence the planet earth from some form of matter like water according to Genesis 1:1–2. The authors do not tell us how this earth can be formless and void as described in verse two or how atoms which make up earth's elements can exist for at least half a day without light, that is, electromagnetic radiation. A second example is the explanation of what provided the light for days 1–3 before the sun was created. To quote the authors, "When God created light, He separated it from darkness. If he did this near the earth, then there would have been a gradient, or other kind of disjunction, between the two, in our region of space" (p. 228). This coupled with the rotation of the earth provided the daytimes and nights until the creation of the Sun. What is the source for the light from empty space since it is not made up of atoms which produce all the light in the present universe?

Another example of a weakness in the thelein model is the creation of the sun, moon and stars on day four from nothing. Would God create the heavens and the earth on day one, call what can be seen in the sky of earth "heavens" on day two, and then create the majority of its visible content on day four? In my opinion the scientific mind must seek answers to these questions that are biblical but also logical and the product of an Intelligent Designer.

Chapters 7 first gives the two models their individual scores based on criteria internal to each model and then compares the models on common criteria. Since the authors dismantled the Big Bang and upheld the thelein model, the scores can be predicted. Chapter 8 is the authors' prediction that there is very little in the Big Bang model that can be changed to make the overall scores change. The epilogue presents to the reader the choice of which model best describes the universe.

Appendix A describes alternative evolutionary models not generally accepted today. Appendix B presents the theological issues involved in the rejection of the Genesis creation account.

Appendix C contains the detailed score cards used in chapter 7. Appendix D contains a copy of an open letter to the Scientific Community from *New Scientist Magazine* (Lerner, 2004) which states that the Big Bang model relies too significantly on hypothetical entities that have not been observed. The letter is signed by many leading astronomers, physicists and other scientists.

This book should be of interest to those who are interested in the origin of the universe. It is definitely biased toward the creation account as presented in the Bible. According to the authors the Big Bang model with all its elaborate mathematical underpinning is a hollow shell waiting to collapse.

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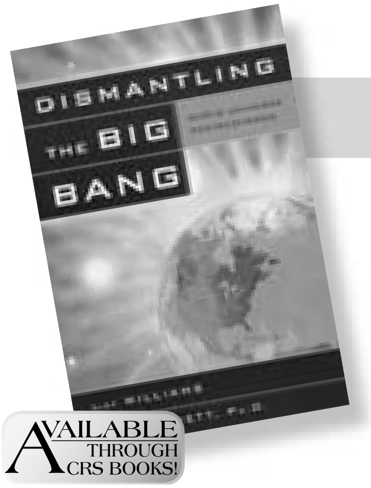

Book Review

Dismantling the Big Bang

by Alex Williams and John Hartnett

Master Books, Green Forest, AR, 2005, 346 pages, $15.00.

There is far more in this book than the title implies. It is a powerful defense of the young earth biblical worldview and is quite comprehensive in scope. The authors systematically dismantle big bang cosmology and expose the highly exaggerated, inaccurate claims of its proponents. They do so in language that is down-to-earth and with illustrations that help communicate concepts that are not easy to grasp. By the time the post-mortem of the big bang is finished, one marvels at the adoption by the establishment of this particular naturalistic model for the origin of the universe. One of the authors (J.H.) is an expert in cosmology who has contributed articles on the subject to international journals. His assessment of a number of competing naturalistic cosmological models is quite helpful. Creationists are not the only ones who are frozen out of the current scientific establishment. The other author (A.W.) has had a long experience in the creationist movement and has written articles on a range of topics. The benefit of some of his wide experience in the battle for truth is encapsulated in this book. The authors' theological insights are edifying and appeal to reason is powerful. The comparison between rival world views is analytical. The method of the authors follows the pattern of the Apostle Paul in demolishing ideologies and vain imaginations that are exalted against knowledge of God, bringing into captivity every thought to the obedience of Christ (2 Cor 10:5 loosely paraphrased).

One of the authors (J.H.) has proposed an interesting variation on Russell Humphreys' model for light from distant stars. The proposal relates to the distribution of "the waters above." The explanation for the difference between earth time and cosmic time is based on relativity theory. The repeated statements throughout Scripture that God "stretched out the heavens" are a major justification for the model. A very reasonable understanding of these verses is that God expanded the celestial heavens in creating the universe. Astronomers other than Edwin Hubble might have discovered evidence for an expanding universe if they had taken notice of these verses. Since the speed of light (c) is equal to distance traveled over time, an expansion of space necessarily implies a corresponding increase in either c or time. Scripture and relativity theory both sit more comfortably with a constant c, leaving cosmic time as the variable.

The authors state their objectives for the book on page 20, one of which is very challenging, "We have opportunities today to glorify God and to enlighten, edify, and encourage His people in ways that none before us have ever had. Let us use those opportunities while we may, and be found still at work when the Master comes to take us home."

Typographical errors are few and there is a comprehensive index. References are given at the foot of the page on which they occur which is a help to the reader. I believe this is an outstanding book that should be in the arsenal of all who are earnestly contending for the faith once delivered to the saints.

Ralph Matthews
Sydney, Australia

Photographic Essay

The Creation Research Society Herbarium: a Progress Report

by George F. Howe*

A herbarium is a collection of pressed, dried plants that have been identified, mounted, and labeled (Figure 1). Mothballs are placed with the specimens to prevent damage by insects. The plants are kept indoors, free from excess moisture and extreme temperatures. Specimens stored in herbaria [plural] can remain useful for many years. Even features of cellular anatomy such as epidermal guard cells can be studied successfully from preserved plants. Herbarium collections are found at many college and university botany departments, large museums, and botanic gardens. Some fine personal herbaria are also maintained by individuals who have built their own collections and have stored them in their homes or offices.

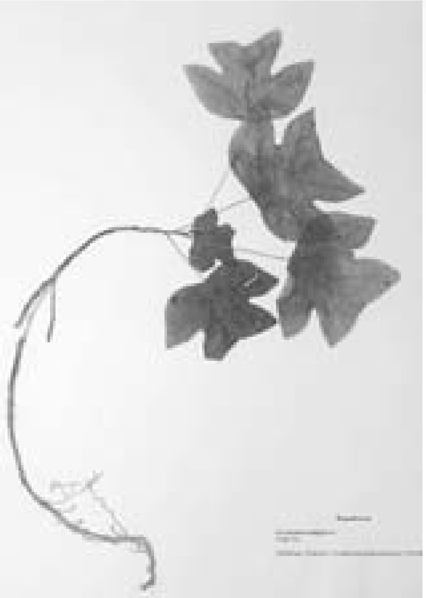

Figure 1. A herbarium specimen inside its "genus cover." This one is *Liriodendron tulipifera L.*, the "tulip tree." These eastern deciduous forest trees are called tulip trees because their flower resembles a tulip and their leaf looks like the profile of a tulip—even though they are in an entirely different family.

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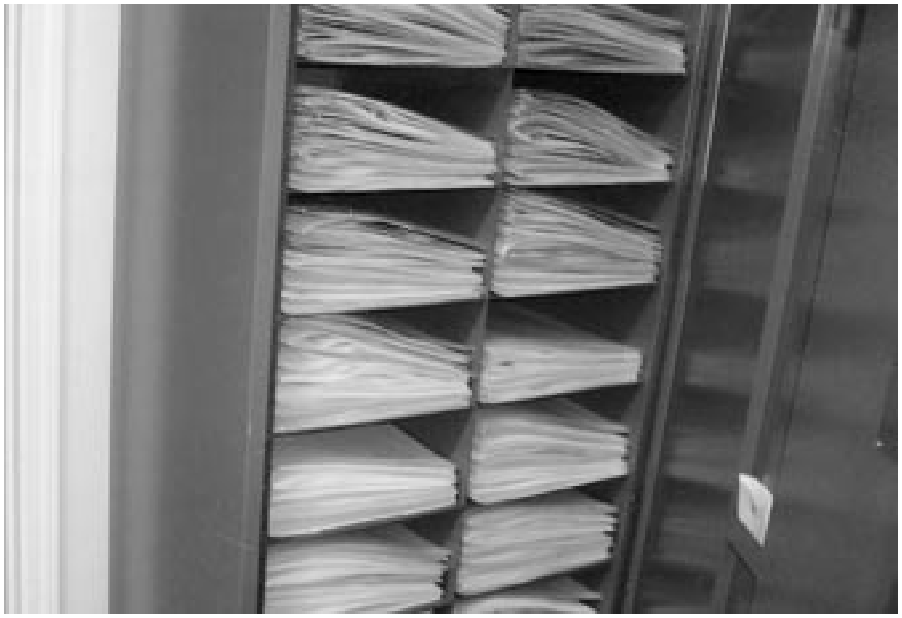

Figure 2. The main Creation Research Society herbarium cabinet. The shelves contain plants filed in genus covers. Note jar with insecticide, lower left.

Figure 3. A closer view of genus covers in the metal herbarium cabinet.

A herbarium can help in the study of plant taxonomy, which is the identification and classification of plants. With the help of a herbarium, plants can be identified quite specifically. Individuals using a herbarium range from qualified students on up to Ph.D. scientists. It is easy for practicing scientists to obtain access to herbaria, while people with less experience may use the collections under proper supervision.

Herbarium plants may be used to study very similar species, especially when microscopic differences are the criteria for separating one species from another. Using specimens collected over a period of years, it may become possible to study shifts in the ecological "cover" in a region. Herbaria may be a resource of great value to "baraminologists," who attempt to determine the limits of the Genesis created "kinds." The characteristics of many similar mounted species can be compared and changes occurring within a given species can be analyzed. It will be possible to assess whether or not any evolutionary changes have taken place.

In the late 1980s the Creation Research Society (CRS) herbarium began to take shape, thanks to the efforts of Joneen Cockman, its first curator. Her work and all other work on the CRS herbarium have been done on a volunteer basis. She secured some Arizona plants and also identified specimens that had been collected in Arizona and elsewhere by Emmett Williams, Steven Hagberg, George Howe, and others. Cockman's identifications of these plants were verified by her associates in plant taxonomy. She published a helpful article describing the CRS herbarium and telling how to collect, press, and label plants (Cockman, 1988). A short note also appeared (Howe, 1988) telling how a herbarium can have value in creation science.

After the Van Andel Creation Research Center (VACRC) was built in the early 1990s, John Meyer saw the value of preserving the herbarium and purchased a sturdy, metallic, herbarium cabinet for the collection—see Figures 2 and 3. But little further development of the collection itself occurred in the 1990's.

In September 2001 Stephen B. Austin started working on the CRS collection and has been its curator from that time to the present. He is an avid plant taxonomist from Fruita, Colorado, and has identified hundreds of plant species. His work is known and recognized at herbaria in Grand Junction, Colorado and in Denver. On several collecting trips he has greatly extended the number of Arizona plant species and has increased the CRS holdings from Colorado and other western states as well (see Figure 4).

Recently Mark Armitage secured the Byron Deshler herbarium from a college in Southern California and helped transport it, together with its wooden cabinet (Figure 5) to VACRC at Chino Valley, Arizona. Austin combined this Deshler collection and another herbarium donated by Mary Carse of Hinesburg, Vermont, with the CRS herbarium. Donated plant collections help to increase the size and usefulness of the CRS herbarium, which now contains 1320 specimen sheets from 509 genera in 125 different plant families. While this is a substantial beginning, much more needs to be done.

If other herbaria become available

as gifts, readers are encouraged to communicate that information to Austin at creationbotanist@gobrainstorm.net. Individuals interested in collecting, mounting, and contributing plants for the CRS collection should also contact Austin and consult Cockman (1988) or some other herbarium publication for proper procedures. Correspondence is welcome from volunteer taxonomists who would like to take part in collection and identification of plants. We would be pleased to hear from individuals who might know of herbarium cabinets, plant taxonomy equipment, or taxonomic books to be donated to the growing herbarium library. We welcome inquiry from those who might wish to use the CRS plant collection for creation studies.

Figure 4. Austin and others, collecting Arizona plants on a road up to Big Bug Mesa, southeast of Prescott, AZ, in the Bradshaw Mountains, September2005. People from left to right are: Barbara Austin, John Meyer, Stephen B. Austin, and George Howe.

Acknowledgments

Although I am alone responsible for any oversights or errors in this report, I thank Stephen B. Austin, John Meyer, and Emmett Williams for useful editorial suggestions offered during its preparation. I am also grateful to John and Jeri Meyer for the photographs.

Figure 5. The wooden herbarium cabinet of the Deshler collection, now being used to hold part of the Creation Research Society herbarium.

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Book Review

One Small Speck to Man: the Evolution Myth

by Vij Sodera

Vij Sodera Productions, U.K., 2003, 462 pages, $50.00 (hardcover).

Vij Sodera, physician and a Fellow of the Royal College of Surgeons of Edinburgh, has a special interest in animal biology. His natural history studies have taken him to East Africa, Canada, and Iceland where he has studied and photographed diverse forms of wildlife. Although he was taught only evolution at school and university, Sodera realizes that the theory is based on very tenuous and unconvincing evidence. This book is the result of 14 years of rigorous research on the scientific evidence for biological origins. The text tries to answer the question, "Is it possible that a dust particle, composed of simple molecules will, after a few billion years, bond with other simple particles and eventually acquire consciousness—to ultimately peer down on another dust particle and contemplate its origins?" (cover page).

Inherent in the theory of evolution by natural selection is the assumption that not only is evolution possible, but that it actually happened. The orthodox evolution theory claims that simple molecules dissolved in water became living cells without any outside influence. Some of these cells became fish, others amphibians, reptiles, birds, mammals, monkeys, and some became you and me. Sodera stresses that "only by looking at all of the evidence objectively (and being willing to challenge established dogma) can we hope to get to the truth" (cover page).

The author effectively catches the reader's attention with his lively discussions in 464 generously-sized (8½ x 11 in.) glossy pages. The hardbound book has over 800 original full color photographs, diagrams, and paintings. The anatomical dissections, most of the photographs, and all of the artwork and diagrams were done by Sodera. The author, an accomplished wildlife artist, has exhibited and sold many of his paintings.

This tome provides a detailed and up-to-date discussion of the scientific problems with macroevolution. It deals purely with the science to provide extensive compelling scientific evidence that macroevolution is a myth. The many topics covered include coelacanths, Human-Ape fossils, whales, elephants, snakes, birds, molecular biology, embryology, dinosaurs, muscle contraction, fossils, sedimentary rocks, mass extinctions, genetic variation, DNA and protein, molecular machines, the eye, human fossils, the human upright gait, human chromosomes, and the mind.

Readers comments include 'beautifully presented', and 'an extraordinary revelation.' Another writes "a world class book that has provided a new paradigm by which to view the evolutionary myth." One reviewer wrote that he believes this book will help change the direction of biology in seeking answers to the origin of life. One strength of the modern scientific community now reevaluating macroevolution is the large variety of people from many countries and diverse scientific disciplines that are contributing to the research. This book, with its many original arguments, is one more example.

Sodera's travels have contributed to his lifelong work in the field of biological origins which is reflected in this book. His medical skills and interest in anatomy, physiology, and biochemistry have allowed him to research in detail evolutionary arguments, especially in the fields of paleontology and biology. He gathers and evaluates data to analyze Darwinism in the light of the principles derived from his experimental and field research. Sodera looks only at the empirical data, and bases his conclusions on this data.

Among the new principles he develops and applies to evolution is the Chalicotherium Principle. Chalicotherium is an extinct animal that had a skull much like a horse, and a body similar to a sloth with arms like a gorilla (pp. 204–205). Sodera cites other examples to illustrate the fact that we cannot determine scientifically the specific morphology of a body from only teeth or skulls as macroevolution has often attempted to do. Likewise, a historical evolutionary relationship cannot be proved solely on the basis of teeth or skull similarity.

Another example—the Coelacanth Principle—is named after the fish once claimed by evolutionists to be an important evolutionary link. Widely believed to have become extinct about 70 million years ago, scientists were forced to totally reevaluate their evolution theories when living specimens were discovered several decades ago. Sodera concludes that, in the absence of any direct evidence to the contrary, any creature could have lived at any time before or after the time of its earliest or latest known fossil, an argument that helps us view the fossil record in a very different light than many evolutionists today (p. 36).

Furthermore, the existing fossil record is a composite artifact. All types of creatures, both living and extinct, could have lived contemporaneously in prehistoric times and there is little empirical evidence for a trend that shows organisms have over time become increasingly complex. Furthermore, the high level of morphological constancy over time manifested by many creatures is evidence against an animal kind having lived for millions of years (p. 51). Sodera also concludes that fossils can be formed in less than a year under very favorable conditions. His original approach allows him to occasionally interpret artifacts differently from other specialists. For example, he suggests that Archaeopteryx was a feathered dinosaur because of its many reptilian features, unlike birds that we know. Furthermore, a step-wise evolution of the bird's supracoracoideus pulley system is very implausible (p. 248).

The chapter on the evolution of the eye is excellent. Sodera shows that many different types of eyes exist in animals, but no pattern exists to indicate an evolutionary trend. For example, vertebrates, from the most primitive fish to the most advanced, humans, show much variety, but no evidence of evolution. The "lowest" type of vertebrate eye is clearly not less complex, just different. Only design modifications were made to enable the animals to live in its environment. Another example is animals thought to be very primitive, such as sharks, that have design features absent in the so-called more advanced animals.

Other examples of principles Sodera has developed include the Disuse Principle (disuse alone will usually not cause degeneration of a structure), the Intermediate Principle (more intermediary fossils types should normally exist then non-intermediate), and a statistical argument called What You Want You Won't Get, meaning it is unlikely that an animal will acquire the mutations needed to evolve into a more complex life form.

Vij Sodera, born in India, has lived in England since the age of four. After earning major school prizes for academic and art achievement at St. Clement Danes Grammar School in London, he graduated from Sheffield University Medical School with distinction in chemistry, and became a Fellow of the Royal College of Surgeons in 1981. During the 20 years he has practiced medicine Sodera has authored three extensively illustrated medical textbooks (*Skin Surgery in General Practice: a Diagnostic Atlas*, *Minor Surgery in Practice*, and *Illustrated Handbook of Minor Surgery and Operative Technique*). Sodera is currently working on two new textbooks on surgery. He also regularly publishes articles in the scientific literature, and plans a television series based on *One Small Speck*. He has published two DVDs on Ape-Human fossils and on the Impossibility of Macroevolution.

Although *One Small Speck* is an expensive book, it is an excellent investment. It is highly recommended for advanced high school and college level readers interested in science as well as church and school libraries as a reference. This work is the only book of its kind, and provides unique insight into the living world. It includes an index, and all references were quoted on the page, in context. Quotes are documented, many from fossil encyclopedias and other academic books. Citations from current textbooks are often used because the focus is on students. Original papers are referenced on matters that are particularly important.

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Isotopic Dating Maximum Datable Age

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Abstract

Isotopic dating using long-lived radionuclides is used to estimate ages of rocks pulled from strata. Closed system behavior is assumed unless discordant results are noted. Concordant or discordant results do not guarantee the system is closed or open. The calculated age without a test of openness/closeness of the system has no merit. A systematic method of determining the age of a multilayered rock structure having open system behavior is proposed. When rock atomic loss constants for different dating methods are similar and much greater than the decay constants, the apparent closed system ages will be similar. A discussion is given as to how much movement of radioisotopes and their progeny from one layer to the next is allowed in order for closed system results to be reliable. The maximum datable age is defined.

Introduction

If isotopes used for isotopic dating were fixed in the geological formations, then determining the age would be relatively simple (as is commonly supposed). Movement of the isotopes is an effect that is understood to have taken place in some formations. When results do not agree with the accepted age, or different isotopic dating methods conflict, open system behavior is often assumed to have taken place. It will be shown that it is difficult to exclude open system behavior as having occurred. A test for open system behavior is proposed and the maximum datable age is defined.

The test, based upon uniformitarian-like assumptions, defines the maximum datable age. The doctrine of uniformitarianism states that past geological processes operate in the same manner and at the same average rate as modern geological processes, assuming all catastrophic events are small and of a localized nature. The maximum datable age uses current open system behavior to place a limit on the calculated age based upon current rates of isotope addition/depletion from a geological layer.

Two mechanisms of loss of parent/progeny can be considered when open system behavior is active, namely first order loss and volume diffusion. Commonly set-up differential equations are of the form

First order loss

$$\frac{dc}{dt} = -k(t)c + p \tag{1}$$

Volume diffusion

$$\frac{\partial c}{\partial t} = D(t)\nabla^2 c + p \tag{2}$$

where c is the concentration of parent/progeny, p is the production rate of the parent/progeny, k is a first order rate coefficient for parent/progeny, and D is a diffusion coefficient (Dodson, 1979). Diffusion is the process of movement of molecules from one part of a system to another as

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a consequence of random molecular motion. Diffusion is strongly temperature dependent. First-order loss is the process where molecules may move from one part of a system to another, but not necessarily as a result of purely random molecular motion. For instance, if water infiltrates the cracks in a geological strata and the net flow is downward, the molecular motion would be more accurately described by first-order loss.

It may seem reasonable that below the closure temperature a mineral should behave as a closed system. Closure temperatures can be experimentally determined or can be predicted based upon the temperature-dependence of the volume diffusion process. However, if first-order loss is the principal mode of molecular movement, then closure temperatures do not represent true closure in the rock. They are calculated assuming diffusion is the principal cause of molecular loss.

Tilton considered the mathematics of volume diffusion for various one-dimensional mineral crystals in whole rock geometries. He noted that the volume diffusion could possibly explain certain discordant lead ages (Tilton, 1960). Nicolaysen demonstrated graphically the apparent age of a mineral versus the true age as a function of the parameter D/a^2 for volume diffusion of the progeny out of the mineral crystal (Nicolaysen, 1957). Here D is the diffusion coefficient and "a" is a diffusion size characteristic of the crystal.

The diffusion effect would be expected to be more pronounced for smaller diameter crystals in geological strata. Large 30 cm diameter Alpine biotites have the same parent to daughter (potassium40 to argon-40) ratio as nearby biotites (< 1 mm in diameter). Dodson considered three possible causes for this anomaly, one of which is that transport is dominated by first-order mechanisms (Dodson, 1979). In this paper, we will consider one-dimensional transport by first-order loss, accounting for radioactive decay for a system consisting of layers of arbitrary thickness. We will demonstrate graphically for first-order transport the apparent versus the true age for depletion of the parent/daughter near the earth's surface, much like Nicolaysen demonstrated the same for depletion of the daughter for diffusion.

Applying first-order loss to open system behavior is a natural extension of how it is applied to closed systems. In a closed system, atoms of the parent/progeny can only decrease/increase by radioactive decay. A *nuclide* is a specific nucleus with a given number of neutrons and a given number of protons. Open system behavior in rock strata can cause nuclides used to date the strata to be exchanged between the layers. In an open system, we also have atoms of the parent and progeny either entering or leaving the volume unit. Consider a rock formation on the earth surface consisting of nuclides A and B in a mineral media, where A decays to B a fraction α of the time, and B is a stable nuclide. If transport of species A and B did not occur between layers within the rock strata, then the first-order differential equation relating the rate of loss/gain of A and B atoms in any rock sample would be

$$\frac{dN_A}{dt} = -\lambda_A N_A \tag{3a}$$

$$\frac{dN_B}{dt} = \alpha\lambda_A N_A \tag{3b}$$

and the solution to the closed system equations when solved for the time since formation is

$$t = \frac{t_{1/2}}{\ln 2}\ln\left(1+\frac{N_B(t)-N_B(0)}{\alpha N_A(t)}\right) \tag{4}$$

where

$t_{1/2}$= half-life of nuclide A

λ_A= decay constant of nuclide A

α= branching fraction—fraction of A that decay to B

$N_A(t)$ = number of atoms of A today

$N_B(t)$ = number of atoms of B today

$N_B(0)$ = number of atoms of B when the rock formed or became closed

t= age of rock

The branching fraction α is necessary for cases such as K/Ar decay, where beta-minus decay occurs 89.3% of the time leading to Ca-40 and electron capture occurs 10.7% of the time leading to Ar-40.

We now address the movement of atoms of nuclide A and B in the rock strata. Consider atoms of one species moving from one layer into an adjacent layer. Let the rock segment have an area A and thickness L as shown in Figure 1. There are initially N atoms in the volume. We allow fluid to infiltrate the rock with a velocity v_w so that the time for the water to exit the rock layer is L/v_w. During this time, a fraction f of the N atoms dissolve into solution and pass with the water out of the volume, so that the rate of atomic removal out of this volume is

$$\frac{f v_w}{L} N$$

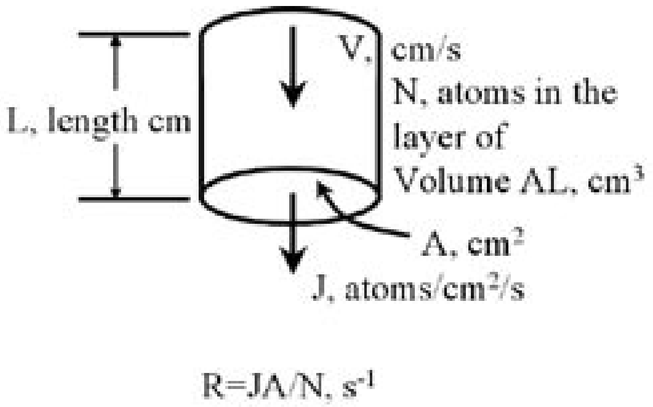

Figure 1. The rock layer atomic loss constant equals the rate of the atoms in volume AL passing through the area A into the adjoining volume divided by the total number of atoms in the layer.

We define the quantity f v_w/L to be the rock layer atomic loss constant (R). It has the same units as the decay constant λ. This is a heuristic explanation of what this rate constants represent and is not meant to be exhaustive. The dynamics driving the process are not considered here, we are only concerned with the kinematics. The rock layer atomic loss constant can also be written as

$$R = \frac{JA}{N} = \frac{J}{\rho L}$$

where J is the atomic current density passing *out* of the volume AL through the surface area A and ρ is the atomic density.

Transport Between Rock Layers and the Atmosphere

We now consider a cylindrical volume of the rock and the air above it as shown in Figure 2. Layer 0 is the atmosphere above the rock that will receive gaseous nuclides from the rock, if the B nuclide is a gas. Layers 1 to p are sequential layers in the rock strata. The differential equations relating the rate of change of nuclides A and B in layer n is

$$\frac{dN_{A,n}}{dt} = -(\lambda_A + R_{A,n,n-1} + R_{A,n,n+1})N_{A,n} + R_{A,n-1,n}N_{A,n-1} + R_{A,n+1,n}N_{A,n+1} \qquad (5a)$$

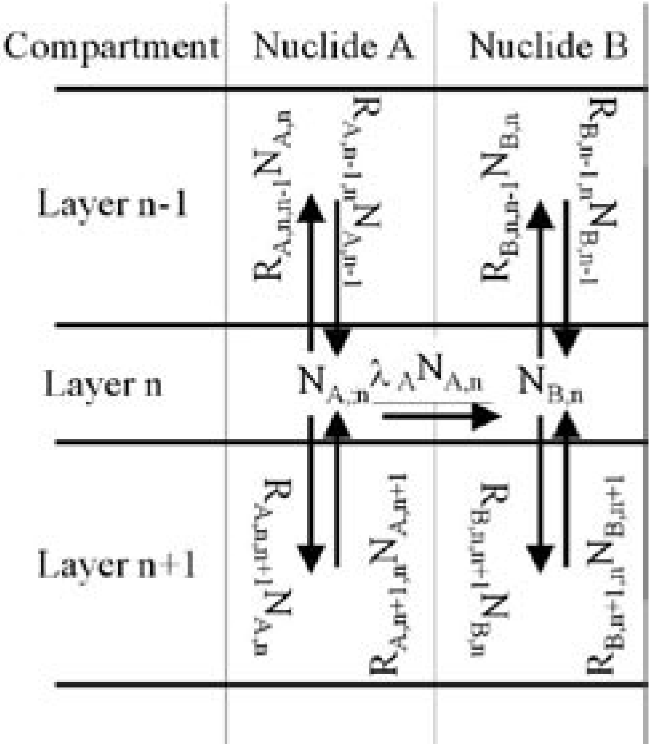

Figure 2. The transport processes in a one-dimensional layered system bounded above by the atmosphere and below by additional layers of rock. Nuclide A can leave layer n by three routes (top, bottom and decay of A) and come into the system by two routes (top and bottom). Nuclide B can leave by two routes (top and bottom) and enter by three routes (top, bottom & decay of A).

$$\frac{dN_{B,n}}{dt} = \alpha\lambda_A N_{A,n} - (R_{B,n,n-1} + R_{B,n,n+1})N_{B,n} + R_{B,n-1,n}N_{B,n-1} + R_{B,n+1,n}N_{B,n+1} \qquad (5b)$$

Equation (5a.) represents the rate of change of A atoms in layer n due to radioactive decay and movement of A atoms into/out of the layer. Equation (5b) represents the rate of change of B atoms in layer n due to gain from radioactive decay of A atoms and movement of A atoms into/out of the layer. The notation $R_{A,n,n-1}$ represents the rock layer atomic loss constant of species A moving from layer n to n-1. To express the above differential equations in terms of concentrations, substitute $N_{A,n}(t)=(AL_n)C_{A,n}(t)$, and $N_{B,n}(t)=(AL_n)C_{B,n}(t)$ where L_n is the thickness of layer n and C is the concentration of nuclide A or B.

Some decay chains have several progeny and in that case, equation 5b can have a decay term ($-\lambda_B N_{B,n}$) added and similar equations set up for progeny C, D, … Z. However, if the half lives of the progeny are short in comparison to the parent, and the progeny rock atomic loss constants are much less than their decay constants, then equations 5 is a suitable approximation where B is the stable end product. This approximation would apply to decay chains commonly used for isotopic dating.

The net atomic current density passing through the interface of layers n, n+1, where down is considered positive is

$$J_{A,net,n,n+1} = \frac{1}{A}\left(R_{A,n,n+1} N_{A,n} - R_{A,n+1,n} N_{A,n+1}\right) \quad (6a)$$

$$J_{B,net,n,n+1} = \frac{1}{A}\left(R_{B,n,n+1} N_{B,n} - R_{B,n+1,n} N_{B,n+1}\right) \quad (6b)$$

and with no net flow, the above two equations would give net current densities of zero.

The rock layer atomic loss constants (R) may increase or decrease, since environmental factors will affect movement of nuclides in the rock. For this analysis we will consider the limitations imposed upon radiometric dating assuming R is nearly constant, which may be a reasonable approximation if the average R over one year intervals does not vary significantly with time. Under this approximation, we desire to understand the limitations of the closed system assumptions where the rock atomic loss constant (R) and their difference from layer to layer may significantly exceed the radioactive decay constant. The variation of atomic loss rate from layer to layer may cause accretion and depletion layers.

There are a number of idealistic boundary conditions that are related as follows:

A. Neither A or B are a gas under normal conditions and the system is closed above and below, so $R_{A,0,-1}$, $R_{A,0,1}$, $R_{A,-1,0}$, $R_{A,1,0}$, $R_{B,0,-1}$, $R_{B,0,1}$, $R_{B,-1,0}$, $R_{B,1,0}$, $R_{A,p,p+1}$, $R_{A,p+1,p}$, $R_{B,p,p+1}$, and $R_{B,p+1,p}$ equal zero.

B. A is not a gas under normal conditions and the system is closed above and below, but B is a gas so that $R_{A,0,-1}$, $R_{A,0,1}$, $R_{A,-1,0}$, $R_{A,1,0}$, $R_{B,0,-1}$, $R_{B,-1,0}$, $R_{A,p,p+1}$, $R_{A,p+1,p}$, $R_{B,p,p+1}$, and $R_{B,p+1,p}$ equal zero.

Under these boundary conditions, the layer 0 to p system is closed to external influx/outflux of species A and B so that there is no net loss or gain of atoms by the system except by radioactive decay. This is the same as saying $N_A(t)$ and $N_B(t)$ satisfy equations (3a.) and (3b.) where these are the solution for the entire system. In general, the lower boundary will tend to be open, so we desire conditions that will let us know whether a given sampled strata will be sufficiently closed over the calculated age for the strata to be confident in the age result. Picking boundaries above and below for a one-dimensional system where the whole system can be assumed to be approximately closed to nuclide transport should improve as the length of the layer increases and the average atomic loss rate of both species (R_A, R_B) decreases and there are no large atomic current densities into/out of the upper or lower boundaries. These conditions can be stated quite simply for the upper and lower boundaries that the amount of nuclide A or B atoms that leak into or out of the boundary in time T must be much less than the inventory in layers 0 to p. Stated mathematically,

$$\begin{aligned} A\left|J_{A,net,0,1}\right|T &<< \sum_{n=0}^{p} N_{A,n}(t) \\ A\left|J_{B,net,0,1}\right|T &<< \sum_{n=0}^{p} N_{B,n}(t) \\ A\left|J_{A,net,p,p+1}\right|T &<< \sum_{n=0}^{p} N_{A,n}(t) \\ A\left|J_{B,net,p,p+1}\right|T &<< \sum_{n=0}^{p} N_{B,n}(t) \end{aligned} \quad (7)$$

where from t=0 to T the above conditions must hold for the upper and lower boundaries for the one-dimensional open system results to be reliable.

For a specific layer n the maximum datable age (MDAge) is operationally defined for nuclide A or B as the current inventory in layer n divided by the magnitude of the net transport rate in/out of that layer. The thicker the layer, the greater the inventory of atoms. The primary limiting factor on MDAge will be how many atoms can you detect going in/out of the layer. If the experimental method can only detect $\pm 10^9$ (billion) atoms/year and the inventory is 10^{18} (billion-billion) atoms, then the maximum datable age would be a billion years.

Systematic Method of Determining the Age of a Multilayered Rock Strata with Open System One-Dimensional Transport

Once the $N_{A,n}(0)$, $N_{A,n}(t)$, $N_{B,n}(0)$, $N_{B,n}(t)$, and the rock layer atomic loss constants are either experimentally determined or estimated with their corresponding uncertainties, each layer will have an estimated age that we can calculate from the solution of equation (5a.) and (5b.) given in the Appendix. We call the ages t_n. Each of the results will have a calculated uncertainty so that for p layers there will be p estimates of the age of the multilayered strata given by $t_n \pm \delta t_n$. The weighted estimate of the age of the rock strata is T and is given by

$$T = \frac{\sum_{n=1}^{p}\left[\frac{1}{\delta t_n^{\,2}} t_n\right]}{\sum_{n=1}^{p}\left[\frac{1}{\delta t_n^{\,2}}\right]} \tag{8}$$

$$\delta T = \frac{1}{\sum_{n=1}^{p}\left[\frac{1}{\delta t_n^{\,2}}\right]} \tag{9}$$

Although the estimates $t_n \pm \delta t_n$ may be very uncertain, the fractional uncertainty of the multilayered result would be less than any individual layer result and for many layers would be expected to be much better. We will consider a simple one/two layer system near the earth surface in the next section and calculate the maximum datable age for the layer, the apparent closed system age and the actual open system age when transport is dominated by nuclide A or B depletion. A one/three layer system can be used to an initial attempt to date deep layers.

General Experimental Method to Determine the Rock Layer Atomic Loss Constants

The diffusion equation's diffusion coefficient is relatively easy to experimentally determine, but the first order loss' rock atomic loss constant is more difficult to resolve. We are describing the method because if first order loss dominates, then it is necessary to experimentally determine the constants. To determine rock layer atomic loss constants (R), a core of the rock should be taken and cut into layers as shown in Figure 3. The layers should be separated and smoothed. An artificial rock or natural rock containing the same mineral content, but smaller concentrations of nuclides A and B should be prepared and cut into corresponding layers. Alternating rock and artificial rock layers will form two columns, one estimating the odd/even rock atomic loss constant, and the other estimating the even/odd atomic loss rates. Blanks of the artificial or natural rocks will be kept for background concentration subtraction.

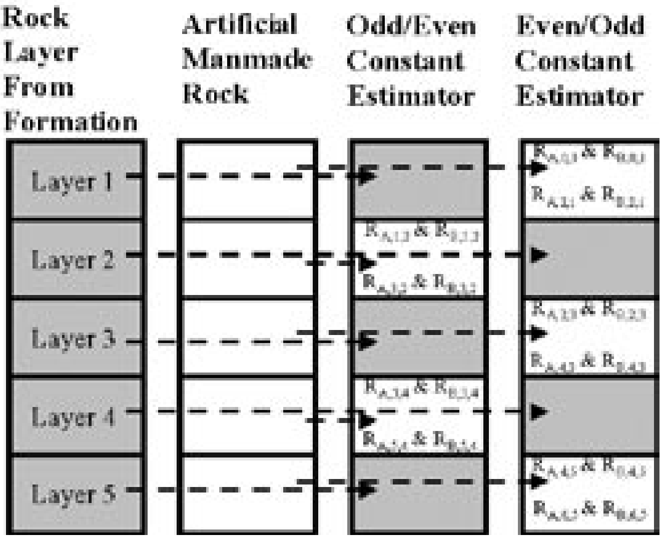

Figure 3. The rock layer atomic loss constant (R) can be measured for a formation where one-dimensional transport is believed to have occurred by separating the layers and stacking native and artificial rock layers under heat, fluid, pressure so nuclide transport can occur for an extended period of time and R can be estimated for the surfaces.

To eliminate uncertainties in natural environmental conditions, the two cores can be taken from the rock in its natural environment and the above process of alternating rock and artificial rock layers repeated in situ. The resulting data would more closely approximate natural conditions without having to know what type of environmental factors may influence the movement of the nuclides.

When the rock and artificial rock layers are interfaced for a period of time (ΔT) under the same or at least similar conditions as the native rock strata, nuclides A and B will move from the rock layers to the artificial rock layers depending on the mobility of the nuclides under those conditions. Over the period ΔT, the amount of movement may be estimated by separating the layers, dissolving the surface of the artificial rocks and analyzing them for trace amounts of nuclides A and B. Dissolving, concentrating and analyzing for nuclides A and B by an integrated light spectrum from the heated sample may be one method of determining the amount of A and B which can be used to calculate the rock atomic loss constants. A similar analysis should be done on blank artificial rocks to see if they produce any spurious counts over a similar counting period for nuclide A and B. If ΔN is the number of atoms that move into the artificial rock layer in a period ΔT and N is the number of atoms in the layer from which the atoms are coming from, then

$$R = \frac{\frac{\Delta N}{\Delta T}}{N} \tag{10}$$

If we treat the N atoms of species A or B in the volume AL as a uniformly distributed fluid that is leaking out the bottom area A (with replenishment from the top) at a rate RN=JA, then the time for all the original atoms in the volume to leak out is 1/R. In that time, an atom at the top has moved a length L, so the average velocity of the particles exiting the bottom of the area A is

$$\begin{aligned} V_{A,n,n+1} &= LR_{A,n,n+1} \\ V_{B,n,n+1} &= LR_{B,n,n+1} \end{aligned} \tag{11}$$

So in a time ΔT, the number of atoms (ΔN) transferred to the artificial layer n+1 from layer n and the average depth to which they penetrate (Δz) is given by

$$\begin{aligned} \Delta N_{A,n,n+1} &= R_{A,n,n+1} N_{A,n} \Delta T \\ \Delta N_{B,n,n+1} &= R_{B,n,n+1} N_{B,n} \Delta T \\ \Delta z_{A,n,n+1} &= LR_{A,n,n+1} N_{A,n} \Delta T \\ \Delta z_{B,n,n+1} &= LR_{B,n,n+1} N_{B,n} \Delta T \end{aligned} \tag{12}$$

The atomic radioactive decay constant λ_A and the rock layer atomic loss constant R are dimensionally the same but represent different physical processes, namely λ_A represents loss/gain due to radioactive decay and R represents loss/gain due to atoms moving from one layer to the next. Without performing experiments to determine the rock atomic loss constants, assuming a closed system is paramount to neglecting the possibility that transport of nuclides in a rock layer that may and most likely will dominate loss/gain of nuclides in that layer. For long-lived radionuclides used for dating rocks, λ_A typically varies between 5 x 10^{-19} to 3 x 10^{-17} s^{-1} and even using experimental periods ΔT=1 year, choosing layers dimensions so the number of atoms is about Avogadro's number (N_0) in the volume AL, and hoping that R is no more than 3 x 10^{-17} s^{-1}, we determine ΔN on the order of 10^{15} atoms and a penetration depths on the order of 100 angstroms (for rock length = 10 cm) into the artificial rock layer.

The original distribution $N_{A,n}$ (0) and $N_{B,n}$ (0) may be inferred by the experimentally determined rate constants and today's distributions $N_{B,n}$ (t) and $N_{A,n}$ (t), assuming this model. The present day distributions are assumed to be due to the original distribution and to accretion/depletion brought about by differing rates of nuclide transport between layers and radioactive decay. If the rate constants R are about the same for each layer and small compared to λ_A, then the present day distributions $N_{B,n}$ (t) and $N_{A,n}$ (t) are simply related to the original $N_{A,n}$ (0) and $N_{B,n}$ (0) by radioactive decay, and the closed system approximation would be satisfactory. If the rate constants vary widely and locations where rate constants are high corresponding to accretion/depletion layers, this would imply the closed system assumption would produce ages that differ significantly from the open system calculated ages. Table I compares how closed system assumptions would calculate differing ages than the open system constant rate model under different atomic loss rate assumptions.

Isochron dating methods assume a closed system. If the data plot on a straight line, then the y-intercept gives information about the initial B nuclide concentration. If the data do not plot on a straight line, the isochron method is invalid. In an open system dating method, calculating the original distribution of A and B is based upon the current distribution $N_{A,n}$ (t) and $N_{B,n}$ (t) and the experimentally determined rock atomic loss constants. This is desirable because although the dynamic processes driving the isotope movement may be known, there could be significant variation in the magnitude of the effect from one position to the next.

Limitation of Closed System Assumptions Near the Earth's Surface

If the only nonzero rock atomic loss constants from layer 1 are $R_{A,1,2}$ and $R_{B,1,2}$, then the solution to the layer 1 differential equations for this open system is

$$\begin{aligned} N_{A,1}(t) &= N_{A,1}(0)e^{-(\lambda_A + R_{A,1,2})t} \\ N_{B,1}(t) &= N_{B,1}(0)e^{-(R_{B,1,2})t} \\ &+ \frac{\alpha\lambda_A N_{A,1}(0)}{(\lambda_A + R_{A,1,2} - R_{B,1,2})}\left[e^{-R_{B,1,2}t} - e^{-(\lambda_A + R_{A,1,2})t}\right] \end{aligned} \tag{13}$$

Scenario A

If $R_{B,1,2} >> R_{A,1,2}$ and λ_A, then

$$\frac{N_{B,1}(t)}{N_{A,1}(t)} \approx \frac{\alpha\lambda_A}{R_{B,1,2}} \tag{14}$$

We place this result into equation (4) to calculate the apparent age ($t_{\text{closed system apparent}}$) based upon the actual open system behavior.

$$t_{closed\_system\_apparent} = \frac{1}{\lambda_A}\ln\left[1 + \frac{\lambda_A}{R_{A,1,2}} - \frac{N_{B,1}(0)}{\alpha N_{A,1}(t)}\right] \tag{15}$$

If we consider the system is actually open below, we have $t_{\text{open system actual}}$ as

$$t_{open\_system\_actual} \approx \frac{1}{\lambda_A}\ln\left[\frac{R_{B,1,2}}{\alpha\lambda_A}\frac{N_{A,1}(t)N_{B,1}(t)}{N_{A,1}(0)^2}\right] \tag{16}$$

So that under the closed system approximation and neglecting the actual open system behavior where the transport is dominated by nuclide B leaving the system, the rock sample appears younger than actuality. The age may even calculate to be a negative value.

Scenario B

If $R_{A,1,2} >> R_{B,1,2}$ and λ_A, then

$$\frac{N_{B,1}(t)}{N_{A,1}(t)} \approx \left[\frac{N_{B,1}(0)}{N_{A,1}(0)} + \frac{\alpha\lambda_A}{R_{A,1,2}}\right]e^{R_{A,1,2}t} - \frac{\alpha\lambda_A}{R_{A,1,2}} \tag{17}$$

We place this result into equation (4) to calculate the apparent age ($t_{\text{closed system apparent}}$) based upon the actual open system behavior.

$$t_{closed\_system\_apparent} \approx \frac{R_{A,1,2}}{\lambda_A}t + \frac{1}{\lambda_A}\ln\left[\frac{N_{B,1}(0)}{N_{A,1}(0)} + \frac{\alpha\lambda_A}{R_{A,1,2}}\right] \tag{18}$$

Here t is the open system age and the open system age estimate for the layer is

$$t_{open\_system\_actual} \approx \frac{1}{R_{A,1,2} + \lambda_A - R_{B,1,2}} \times \ln\left[\frac{\dfrac{N_{B,1}(t)}{N_{A,1}(t)} + \dfrac{\alpha\lambda_A}{R_{A,1,2}}}{\dfrac{N_{B,1}(0)}{N_{A,1}(0)} + \dfrac{\alpha\lambda_A}{R_{A,1,2}}}\right] \tag{19}$$

So that under the closed system approximation and neglecting the actual open system behavior where the transport is dominated by nuclide A leaving the system, the rock sample appears much older than actuality.

By restricting nuclides A and B transport so that depletion of layer one dominates, the solution of the general differential Equations (5a.) and (5b.) reduces to a solution expressible as the simple solution of equation (13). In general, numerical solutions for real-life systems will need to be made. Equation (13) expresses how transport affects the number of atoms of A or B in layer one when the system is open. Figure 4 displays the apparent closed system ages near the earth's surface where depletion of nuclide A or B is governed by Equations (13) and this result is placed into Equation (4) to estimate the apparent closed system age. This figure demonstrates if the rock atomic loss constants are large in comparison to λ_A, the closed system results will differ significantly from the actual age.

Isotopic Dating Maximum Datable Age

As demonstrated in the previous section, when transport of nuclides A and B is significant, the closed system assumptions will give unreliable ages. Here we discuss the one-dimensional open system dating method and its reliability.

For a rock strata divided into layers of length L, the weighted age is given by Equation (8). The maximum datable age(s) are based on current measured transport rates. When the weighted age is much less than the maximum datable age(s), the system may be dated to an age less than MDAge and the result may be reliable.

Figure 4 illustrates that a multitude of different nuclide transport scenarios could mimic any apparent age. Consider a rock with an apparent age of 1 billion years. The rock could be 1 billion years old if the rock atomic loss constants of the parent and daughter are less than 1 x 10^{-10} yr^{-1}. But it could be 100 million years old if the parent has a rock

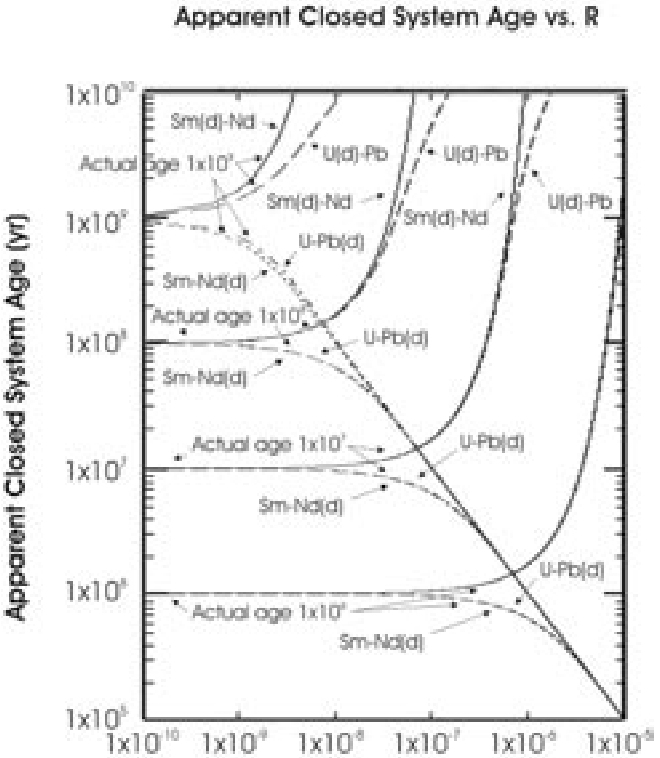

Figure 4. The apparent closed system age near the earth's surface where depletion (d) of either the parent or progeny dominates. Sm-Nd (half life of 106 billion years) and U-235 (half life of 0.704 billion years) curves illustrate that the age distortion increases as the half-life of the dating nuclide increases or as the rock atomic loss constant increases. Here we consider four assumed actual ages 1 million, 10 million 100 million and 1 billion year-old rock strata.

For example, a sample is determined by Sm-Nd dating to have an age of 100 million years based upon closed system assumptions. If only the parent is depleting at the rock atomic loss constant of 1x10^{-7} yr^{-1}, then the actual age is 20 billion years. If only the daughter is depleting at the rock atomic loss constant of 1x10^{-6} yr^{-1}, then the actual age is 1 million years.

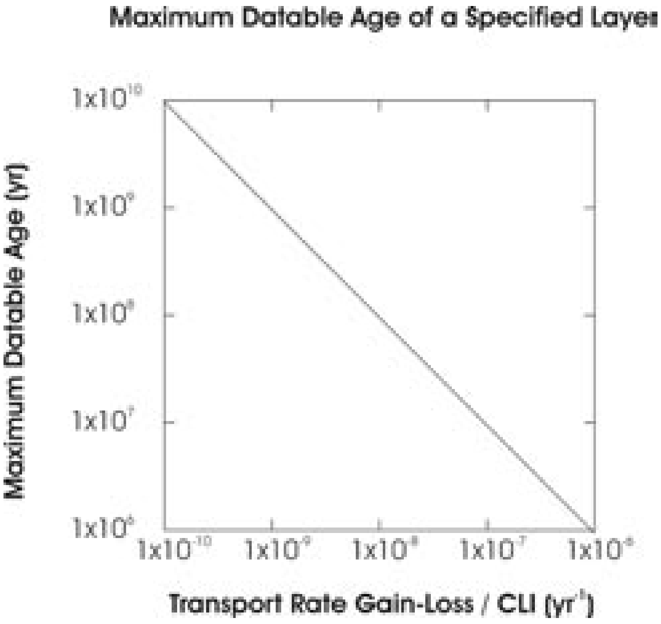

Figure 5. To use this chart, take the experimentally determined value of the transport rate of isotope A or B in atoms-yr^{-1} and divide each by the Current layer Inventory (CLI) atoms of A or B, respectively. Determine the Maximum Datable Age for each isotope A and B and use the lesser MDAge for determining whether an individual layers result are reliable, or whether the scope of the investigation needs to be expanded.

atomic loss constant of 2 x 10^{-10} yr^{-1}. However, it could be 10 billion year old if the daughter isotope has a rock atomic loss constant of 1 x 10^{-10} yr^{-1}. The actual age is strongly dependent on the transport of the parent or daughter isotopes used for the dating method.

Figure 5 illustrates effect of transport on the maximum datable age for layers that are not necessarily near the earth's surface. If the rate of gain/loss of nuclide A or B is great enough from a given layer, any conclusion about the age of that layer alone without additional measured transport results from adjacent layers would be unreliable. The maximum datable age for isotope A is defined as

$$MDAge - A = \frac{N_{A,n}}{\left| -(R_{A,n,n-1} + R_{A,n,n+1})N_{A,n} + R_{A,n-1,n}N_{A,n-1} + R_{A,n+1,n}N_{A,n+1} \right|} \tag{20}$$

but a more practical estimator for those wanting to know whether the experimental method will be sufficient to achieve the desired age range is

$$MDAge - A = \frac{N_{A,n}}{2\delta N_A} \cdot \Delta T \tag{21}$$

where δN_A is the minimum detectable atoms that can be detected as having crossed any boundary. There are a few different scenarios that can be explored for MDAge. One is where nuclides transport is dominated by nuclides leaving layer n. In that case, the MDAge is on the order of $(R_{A,n,n+1} + R_{A,n,n-1})^{-1}$ and where nuclide transport is dominated by nuclides entering from the layer above or below (with $N_{A,n} \approx N_{A,n-1} \approx N_{A,n+1}$) the MDAge is $(R_{A,n-1,n} + R_{A,n+1,n})^{-1}$. When nuclides are entering and/or leaving layer n, the MDAge may be large since the denominator in the MDAge definition may be close to zero.

A simple MDAge equation based on water current density J_w (g/cm^2-yr) flowing through the rock of length L (cm) near the earth's surface is

$$MDAge - A = \frac{100\rho_A L}{J_W S_{A-W}} \tag{22}$$

Where ρ_A is the density of A (g/cm^3) and S_{A-W} is the solubility. The solubility is a unitless number equal to the number of grams of solute of A that can dissolve in 100 cm^3 of water. Even for insoluble compounds of A or B dating isotopes and low current densities, it is difficult for MDAge to achieve a billion year time frame without thick layers.

Solute transport, unlike diffusion transport, has no closure temperature. Below the diffusion closure temperature, solute transport will be the principal cause of dating isotope loss. Dodson (1979) considered first-order loss but assumed the first-order rate coefficient had the same temperature dependence as diffusion. Jenkin et al. (1995) considered Rb-Sr dating systems for bi-mineralic rock. They noted that fluids within the rock can affect closure. No discussion was made as to how much fluid infiltration was allowed in order to have confidence the system was closed and for diffusion loss to dominate. Solute transport is likely to be the primary limitation for isotopic dating of any geological formation on the earth's surface as displayed in Figure 8.

Miller et al. (1991) noted that fluid movement through the rock below the conventional closure temperature might render the system open. The history of the formation could render a given rock sample susceptible to one or more fluids. In particular, the Dalradian rocks of Connemara, Western Ireland had in filled small cracks indicating significant fluid flow after the rock had passed through the closure temperature. The variable nature of the age estimates for different samples indicates the fluid flow may not have been pervasive, but channeled.

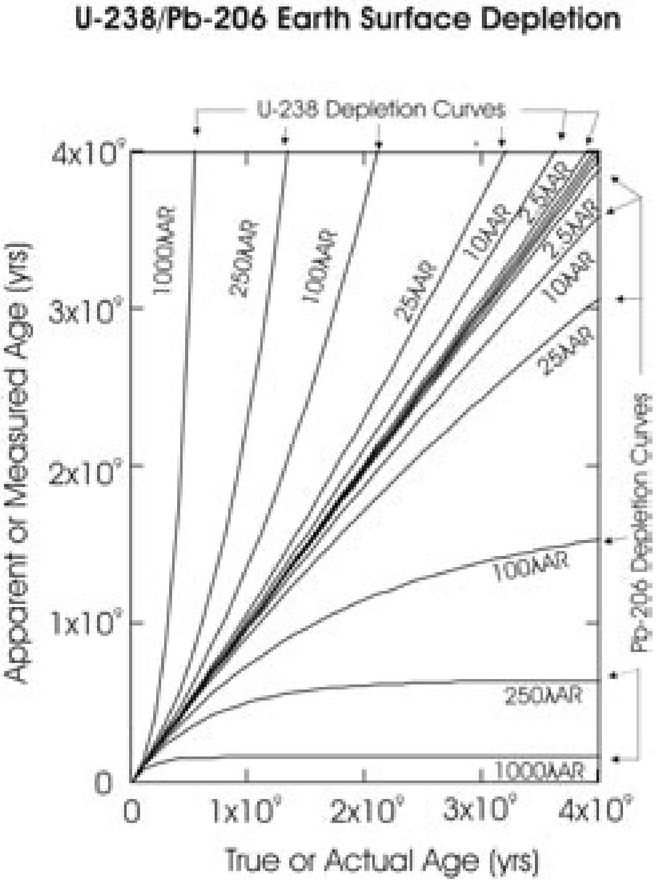

Figure 6. Measured age versus the actual age near the earth's surface where depletion of the parent or daughter dominates. The curves above and below the diagonal represent depletion of U-238 and Pb-206, respectively. The value λAR is selected as the rock atomic loss constant equal to the decay constant of Sm-147 (half life = 106 billion years). Just a little transport of dating isotopes can distort the actual age. Plots for other dating isotopes look similar to this.

Figure 6 illustrates the problem of isotopic depletion of the parent or daughter and the effect on the apparent age versus the actual age. We choose the rock atomic loss constants of the parent or progeny to be multiples of $\lambda AR \equiv 6.5 \times 10^{-12}$ yr^{-1}. If both the parent and progeny are being lost, then it is best to go back to equation (13) and solve it from there.

If there is a dynamic process that causes the rock atomic loss constants for different dating nuclides to be similar and larger than the decay constants, then the apparent ages based upon closed system assumptions may be similar. Elementally U-235 and U-238 dating would be expected

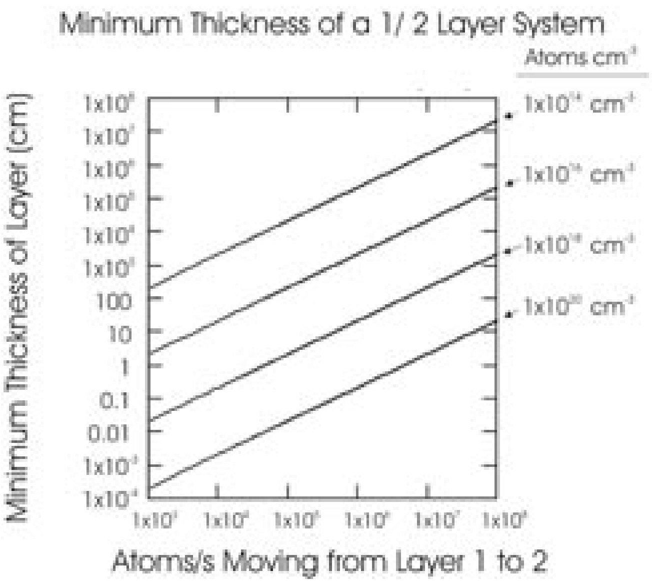

Figure 7. Estimate of the minimum thickness of a one/two layer system near the earth's surface based on the atoms/sec passing from layer 1 to 2 of the parent or daughter. Area of the layer is 10,000 cm^2 and the critical rock atomic loss rate is taken as the radioactive decay rate of U238. A concentration of 1x10^{20} atoms/cm^3 corresponds roughly to a 1% by mass concentration of the parent (U238) or daughter. As the nuclide concentration and area of the layer decrease, the minimum thickness of the layer increases.

to result in similar rock atomic loss constants. In this case, similar age results could either mean the system is closed and the age is the actual, or more likely the system is open and the age is apparent. This is an explanation why different isotopic dating techniques may often give similar results.

Figure 7 shows the minimum thickness of a one/two layer system as a function of the rate that atoms are passing from layer 1 to 2 (K_a) by selecting the critical rock atomic loss constant ($R_{A,1,2}$) and calculating

$$Minimum\_thickness \approx \frac{K_A}{R_{A,1,2}\,\rho_{atomic}\,A} \qquad (23)$$

There are a number of conditions that could cause this open system dating method to produce unreliable results, although current conditions may appear to produce reliable results. Some of these conditions are as follows:

1. The rock atomic loss constants have not been constant for the time 0 to T. If the values varied significantly in the past from their current values, this could significantly increase or decrease the calculated age. Unusual environmental conditions over a short period could result in transport of nuclide A and/or B that could mimic ages either less than or greater than the actual time.
2. If the system does not behave as one dimensional, but significant transport occurs perpendicular to the assumed axis of transport, then nuclides A and B can enter/leave in a way not accounted for by one-dimensional transport. Three-dimensional transport may be required for these types of rock strata. This paper does not consider three-dimensional transport.

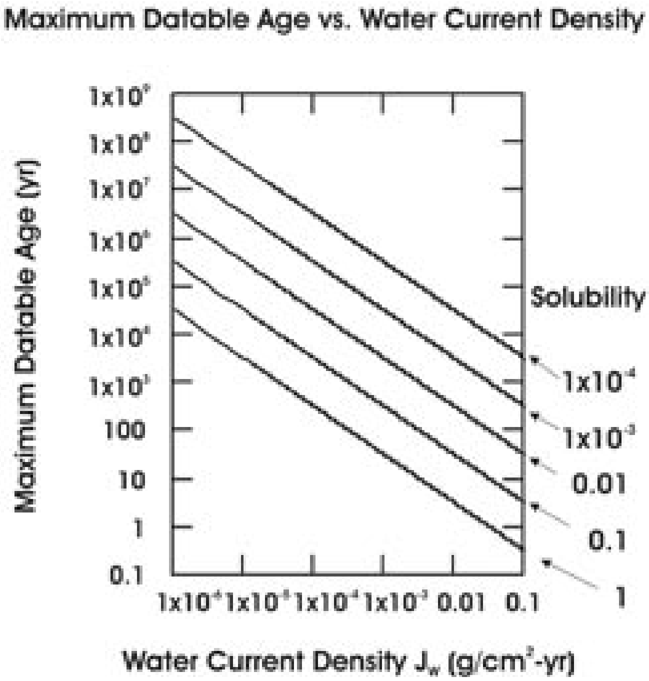

Figure 8. The maximum datable age for a rock sample is strongly dependent on the solubility of the dating isotopes and the water flow through the rock. The graph is for a 100 cm long rock core where the dating isotopes are insoluble (10^{-4} g per 100 ml of water) to soluble (1 g per 100 ml of water). Concentration is 1 PPM and density of rock is 3 g/cm^3. A combination of high concentrations of dating isotopes, long rock cores, low water flow rates, and insoluble dating isotopes are required to achieve maximum datable ages of a billion years. For comparison with the water flow through rock, rainfall in arid regions may be 10 g/cm^2-yr. A small fraction of this rain penetrating the rock may render the system open.

3. When erosional processes have taken away layers above or below the present day surface layer. Thus, nuclides could have leached into/out of the present layers from a layer that no longer exists and that we cannot reasonably account for.

Just as the ages calculated for rocks or strata assuming closed system behavior may not represent the actual time since formation, so the calculated age assuming one-dimensional transport may be more reliable but the age may still differ from the actual time since formation.

Summary

The whole-rock isochron method based upon a cogenetic suite of rocks will likely produce meaningless results if isotopic transport rates vary significantly with horizontal location. The isochron diagram generated for a cogenetic suite where the rock sample results produce concordant results could be the result of random chance coincidence driven by differing isotopic transport at different locations if the number of sampled rocks is small enough. Isotopic transport needs to be accounted for to have confidence in any calculated age.

It is operationally necessary for the closed system or open system results to be less than the maximum datable age. If it can be reasonably argued that isotopic transport has not been significantly greater than the current transport rate, then this could be a sufficient condition to have confidence in the calculated open system age. To verify that isotopic transport has not been significantly greater in the past, subjecting samples to laboratory conditions similar to those believed to have existed in the past, could verify transport would not have significantly impacted the maximum datable age restriction on the calculated open system age.

When various types of igneous/metamorphic strata are determined to typically have high isotopic transport rates, this may require the use of thick layers. The thickness would be the prime limiting factor for thin igneous layers. The isotopic transport into/out of the layer by sedimentary layers above/below this would be a confounding factor that could limit the maximum datable age due to isotopic transport into/out of the layer based upon a source of isotopes that cannot be dated.

Near the earth's current surface or near interfaces between geological strata of different transport properties, closed system approximations may over/under estimate the actual age depending on the movement of the isotopes between layers over the ages. The age estimated using the open system one-dimensional transport model could result in a more reliable age estimate if the number of layers and their total length is great enough that insignificant amounts of the dating nuclides leak out of the upper and lower boundaries during the estimated age. A surprising result is that different isotopic dating methods can produce similar apparent closed system ages if the isotopic transport rates of the dating nuclides are similar. **However, for cases where both mineral isochrons and whole rock isochrons give the same erroneous age, this paper has not proven that a fluid transport explanation is sufficient.** When rock atomic loss constants of different isotopic dating methods are the same and much greater than the decay constant, the calculated "erroneous" ages will be the same for the different isotopic dating methods. However, the values of the atomic loss constants are not readily available in the relevant papers of the literature.

Diffusion is an insignificant mode of dating nuclide loss. Water flow through rock at unmeasurably low-levels can cause different dating methods to give coincidentally the same age. Movement of dating nuclides in rock fundamentally limits the isotopic dating method.

Acknowledgements

I would like to thank Dr. Keith Wanser and John Woodmorappe for kindly commenting on a previous version of this paper.

Appendix on Mathematical Considerations for a One Two Layer System

We now consider a rock stratum near the earth's surface and consider the problem of determining its age with an open system kinematic back calculation by experimentally determining the rock atomic loss constants for layer 1 and upper part of layer 2. This one/two layer approximation may be sufficient for some strata. For simplicity, we number the steps in the process.

Step 1: A representative composite sample of the strata is taken from the strata. The following data is experimentally determined:

ρ_s = density of strata, g/cm^3
PPM_A = parts per million of nuclide A in the composite of strata
PPM_B = parts per million of nuclide B in the composite of strata

Based upon this information, we can calculate the "first approximation" closed system age, assuming all the atoms of nuclide B are radiogenic from the atoms of nuclide A in layer 1. That is, $N_{B,1}(0) = 0$ and $N_{A,1}(0) = N_{A,1}(t) + N_{B,1}(t)/\alpha$ where t = today. This may not be the case, since A and B can leak into or out of layer 1.

Step 2: We need to estimate the thickness L and area A of layer 1, based upon the understanding that the closed system results will become increasingly unreliable if $R_{A,1,2}$ or $R_{B,1,2}$ are significantly greater than λ_A and the minimum detectable number of atoms (δN_A or δN_B) that the experimental method can determine in the artificial rock as limiting factors. The number of atoms crossing the boundary must be greater than the minimum detectable atoms (δN) in ΔT. The limiting condition for the A and B nuclides for layer 1 can be written as

$$\frac{\delta N_A}{\Delta T} \le R_{A,1,2} N^0_{A,1}(t)$$
$$\frac{\delta N_B}{\Delta T} \le R_{B,1,2} N^0_{B,1}(t) \qquad (24)$$

where we seek to determine the minimum number of atoms of A or B that must be in the layer, which will be used to estimate the required volume AL of the strata. Now the rock atomic loss constants can produce unreliable closed system results if they are on the order of λ_A or greater and the zero order approximation of $N_{A,1}(t)$ and $N_{B,1}(t)$ is given by step 1 derived parameters in the following relations:

$$N^0_{A,1}(t) = \frac{N_0 \rho_s AL \frac{PPM_A}{1x10^6}}{W_{M-A}}$$
$$N^0_{B,1}(t) = \frac{N_0 \rho_s AL \frac{PPM_B}{1x10^6}}{W_{M-B}} \qquad (25)$$

Solving for the volume of rock that must be sampled, it is the greater volume of the following two conditions:

$$(LA)_A = \frac{\frac{\delta N_A}{\Delta T} W_{M-A}}{\lambda_A N_0 \rho_s \frac{PPM_A}{1x10^6}}$$
$$(LA)_B = \frac{\frac{\delta N_B}{\Delta T} W_{M-B}}{\lambda_A N_0 \rho_s \frac{PPM_B}{1x10^6}} \qquad (26)$$

The greater the area (A) of the rock/artificial rock interface, the greater the number of atoms that will be available to pass over the interface. If we take the volume to be a cube of height L and area $A=L^2$, then we can solve for the height of the volume element.

Step 3: We build three artificial rocks of dimensions L x L x L. Chemically they are the same as the rock strata, except they do not have the two isotopic dating nuclides A or B, but could be doped with chemically similar nuclides A' and B' in hope that there will be no preference for the A and B nuclides to move either to the artificial rock or to the natural rock. The atomic concentrations in the artificial rock are adjusted so that $PPM_{A'} /W_{A'} \approx PPM_A/W_A$ and $PPM_{B'} /W_{B'} \approx PPM_{B'}./W_B$ where W are the molar weights. This is done to assure that it is unlikely that the lack of nuclides of A or B in the artificial rock strata will not cause accelerated movement across the interface. For core 1 of the sampling strata, one artificial rock will fit between layer 1 and 3, and for core 2 we have an artificial rock at layer 1 and natural rock beneath it. The last artificial rock strata will remain in the laboratory as a blank to have whatever tests performed on it that the in situ artificial rock layers received, to see if any spurious counts may be determined on the blank, implying a small trace concentration of A or B and for calculating the minimum detectable atoms in the artificial rock surface. A thin A & B isotope permeable membrane may be used between the layers to aid in the separation of the layers.

Step 4: The surface of the *in situ* artificial rock layers are separated from the natural rock and the three artificial rock layers are tested to determine the amount of A and B nuclides that leaked in time ΔT, and then $R_{A,1,2}$, $R_{B,1,2}$, $R_{A,2,1}$, and $R_{B,2,1}$ are calculated. Also, layer 1 and 2 of the natural rock is analyzed to determine $N_{A,1}(t)$, $N_{B,1}(t)$, $N_{A,2}(t)$ and $N_{B,2}(t)$. Then $J_{A,1,2,net}$ and $J_{B,1,2,net}$ are calculated. The maximum datable age (MDAge) is

$$MDAge - A \equiv \frac{N_{A,1}(t)}{J_{A,1,2,net} A}$$
$$MDAge - B \equiv \frac{N_{B,1}(t)}{J_{B,1,2,net} A} \qquad (27)$$

If the time calculated with the closed system assumption is significantly greater than this, the closed system result is called unreliable.

Step 5: If the system appears quite open and depletion is occurring for this layer, and if the following conditions hold:

$$\begin{aligned} R_{A,1,2}N_{A,1}(t) &> R_{A,2,1}N_{A,2}(t) \\ R_{B,1,2}N_{B,1}(t) &> R_{B,2,1}N_{B,2}(t) \end{aligned} \tag{28}$$

then it may be possible to date the layer using equations (13). If the assumption $N_{B,1}(0)=0$ is valid, then the open system time is calculated to be

$$T_{open\_system\_depl\_dominates\_layer1} \approx$$

$$\frac{1}{\lambda_A + R_{A,1,2} - R_{B,1,2}} \ln\left[1 + \frac{N_{B,1}(t)}{N_{A,1}(t)}\left(1 + \frac{R_{A,1,2} - R_{B,1,2}}{\lambda_A}\right)\right] \tag{29}$$

If this calculated open system age is significantly greater than MDAge, the result is termed unreliable and the strata cannot be dated with just this one layer. If the result is less than MDAge, then the result may be reliable if it is much less than MDAge.

Step 6: When the closed system and open system results are determined to be unreliable because nuclide A and B are leaking out or into the strata at a high rate, then either select additional layers or do an additional experiment where the new length of the layer L is selected for a one/two layer system in anticipation of what the maximum datable age may be for that height of a layer. Here we have used a one/two layer system near the earth's surface with two cores of natural/artificial and artificial/natural. A one/three layer system could be used to determine the maximum datable age deeper in the earth with two cores of natural/artificial/natural and artificial/natural/artificial layers at the same depth.

Appendix on General Solution to the First Order Loss Equation

A general solution of equations (5a.) and (5b.) can be written as:

$$N_{A,n}(t) = N_{A,n}(0) + \sum_{i=1}^{\infty} M_{A,n,i}t^i \tag{30}$$

$$N_{B,n}(t) = N_{B,n}(0) + \sum_{i=1}^{\infty} M_{B,n,i}t^i \tag{31}$$

where $M_{A,n,i}$, and $M_{B,n,i}$ are coefficients of the Maclaurin series expansion given by the following recurrence relations:

$$\begin{aligned} M_{A,n,i+1} = \frac{1}{i+1}\Big[&-\left(\lambda_A + R_{A,n,n-1} + R_{A,n,n+1}\right)M_{A,n,i} \\ &+ R_{A,n-1,n}M_{A,n-1,i} + R_{A,n+1,n}M_{A,n+1,i}\Big] \end{aligned} \tag{32}$$

$$\begin{aligned} M_{B,n,i+1} = \frac{1}{i+1}\Big[&\alpha\lambda_A M_{A,n,i} - \left(R_{B,n,n-1} + R_{B,n,n+1}\right) \\ \times\ &M_{B,n,i} + R_{B,n-1,n}M_{B,n-1,i} + R_{B,n+1,n}M_{B,n+1,i}\Big] \end{aligned} \tag{33}$$

where $M_{A,n,0} = N_{A,n}(0)$ and $M_{B,n,0} = N_{B,n}(0)$. Using the recurrence relationship of equations (32) and (33), and the following definitions:

$$\begin{aligned} \varepsilon_{n,-1} &\equiv R_{A,n-1,n} \\ \varepsilon_{n,0} &\equiv -\left(\lambda_A + R_{A,n,n-1} + R_{A,n,n+1}\right) \\ \varepsilon_{n,1} &\equiv R_{A,n+1,n} \\ \delta_{n,-1} &\equiv R_{B,n-1,n} \\ \delta_{n,0} &\equiv -\left(R_{B,n,n-1} + R_{B,n,n+1}\right) \\ \delta_{n,1} &\equiv R_{B,n+1,n} \end{aligned} \tag{34}$$

we can then write the general term of the Maclaurin series expansion of equations (30) and (31) for the open system multilayered solution as:

$$\begin{aligned} M_{A,n,k} = &\frac{1}{k!}\sum_{i_1=-1}^{1}\sum_{i_2=-1}^{1}\cdots\sum_{i_k=-1}^{1} \\ \times\ &\left[\varepsilon_{n,i_1}\varepsilon_{n+i_1,i_2}\cdots\varepsilon_{n+i_1+\cdots+i_{k-1},i_k}N_{A,n+i_1+i_2+\cdots+i_k}(0)\right] \end{aligned} \tag{35}$$

$$M_{B,n,k}=\frac{1}{k!}\sum_{i_1=-1}^{1}\sum_{i_2=-1}^{1}\cdots\sum_{i_{k-1}=-1}^{1}\left\{\begin{aligned}&\alpha\lambda_A\left[\begin{aligned}&\varepsilon_{n,i_1}\varepsilon_{n+i_1,i_2}\cdots\varepsilon_{n+i_1+\cdots+i_{k-2},i_{k-1}}\\&+\sum_{p=1}^{k-1}\delta_{n,i_1}\delta_{n+i_1,i_2}\cdots\delta_{n+i_1+\cdots+i_{p-1},i_p}\varepsilon_{n+i_1+\cdots+i_p,i_{p+1}}\cdots\varepsilon_{n+i_1+\cdots+i_{k-1},i_k}\end{aligned}\right]N_{A,n+i_1+\cdots+i_{k-1}}(0)\\&+\sum_{i_k=-1}^{1}\delta_{n,i_1}\delta_{n+i_1,i_2}\cdots\delta_{n+i_1+\cdots+i_{p-1},i_p}N_{B,n+i_1+\cdots+i_k}(0)\end{aligned}\right\}. \tag{36}$$

It is readily verifiable that the above solution reduces to simple closed system exponential if the rock layer atomic loss rate are set equal to zero, then the solution can be manipulated and expressed as the solution of equation (4).

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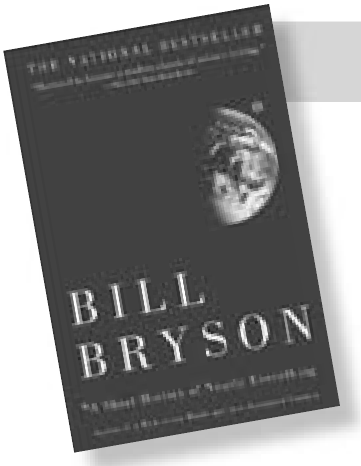

Book Review

A Short History of Nearly Everything

by Bill Bryson

Broadway Books, New York, 2003, 544 pages, $18.00 (hardcover).

As a Main Selection of the Book-of-the-Month Club, this book will become widely read. Therefore we should become acquainted with it in order to understand major influences in our society. The author has a writing style that makes the book engaging reading, even for individuals who are not particularly interested in the scientific issues that are treated.

Most of the pages contain one or more quotations from the author's source material including publications, correspondence, personal interviews, and public records.

Beginning with concepts regarding the nature and origin of the universe, the author traces the development of materialistic modeling concerning elementary matter, geology, organic life, and man. His collection of personal information regarding prominent individuals in this progression of scientific thought will make this book widely treasured. Choice personal items may be readily found by selecting an individual name from the 26 pages of general index. For example, on page 111 we learn that despite being the only person to win a Nobel Prize in both chemistry and physics, Marie Curie was never elected to the Academy of Sciences. The probable explanation is the indiscreet affair she conducted with a married physicist after the accidental death of her husband Pierre, who also was a Nobel Prize winner.

On page 382 we learn that Charles Darwin was noted for lackluster academic performance. He began study to follow his father's career in medicine, shifted to law instead, and finally by default obtained a degree in divinity. Because of his training for the ministry, he was the second choice to be cabin mate and dinner company for the captain of HMS Beagle. Captain FitzRoy's formal assignment was to chart coastal waters but his major interest was the search for evidence in support of a literal, biblical interpretation of creation. Twenty nine years after the celebrated Beagle voyage Robert FitzRoy committed suicide.

In Chapter 24 the simplest living cell is described as far beyond the limits of human ingenuity. The number of cells in a typical human body is placed at ten thousand trillion with at least 200,000 different types of protein. In the conclusion of this chapter Bryson says, "Every living thing, never forget, is a wonder of atomic engineering." In the closing sentence of the chapter he quotes an evaluation by Daniel C. Dennett that Charles Darwin had "the single best idea that anyone has ever had."

Although Bryson's objective is the promotion of materialistic evolution from cosmic Big Bang to modern man, he forthrightly treats scientific difficulties with some crucial stages of the postulated evolutionary sequence. Many paragraphs of this treatment would be choice contributions to a rigorous scientific treatment of earth history according to biblical specifications.

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The origin of man:

Book Review

The Origin of Man: The image of an ape or the image of God

by Stuart Burgess

Send the Light, 129 Mobilization Drive, Waynesboro, GA ,
170 pages, $13.00.

With a captivating title and cover, this publication is an attention grabber, and the text mirrors the heart of its author, Stuart Burgess, who is Head of the Department of Mechanical Engineering at Bristol University in the United Kingdom.

The text's clear purpose is to depict humans as divinely designed. Human similarities with apes readily are explainable "in terms of a common designer" (p. 9) rather than common ancestry with apes. Topics in the book include stature, hands, skin, face, speech, childhood, sexuality, genome, brain, beauty, history, archaeological and fossil evidence, human worldviews, and the glory of man. One rather suave idea which caught my attention was that since many animals have faces, we are able to communicate more meaningfully with them (p. 20). Another attractive thought is that, "Man is the only creature capable of extremely skillful balance on two legs (p. 24).

The book has relatively short focused chapters and overall is easy reading even for those unfamiliar with the subjects. Each of the chapters opens with a summary paragraph printed with a slightly larger font than used for the main text. Author Burgess is strongly opposed to evolution and frequently says that evolutionists do not have answers for origins of various features–speech, written language, facial muscles, or neatness of the hairline. His creation position is that modern man has "essentially the same design as Adam and Eve" who "were created less than 10,000 years ago" (p. 165).

But according to most evolutionists if a feature provides some selective advantage which short- or long-range would contribute to survival, then the feature will be conserved and transmitted.

If the book is revised, the above issues should be made clearer and there should be an increased number of recent quotations including more from evolutionists. The fossil chapter definitely needs updating (addition of Toumai, Flores Man, etc.). Also, it should be stressed that as the numbers of fossil discoveries have increased, they have served to add greater confusion rather than clarity to an evolutionary interpretation.

Overall this book should serve to challenge all readers to a greater respect for the design of our bodies and hopefully point non-Christians to the Designer-Creator, Jesus Christ, and salvation through Him. Also it should help strengthen the faith of Christians in the creation power of the Almighty God.

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Photographic Essay

The Fossil Cliffs of Joggins, Nova Scotia

by Ian A. Juby*

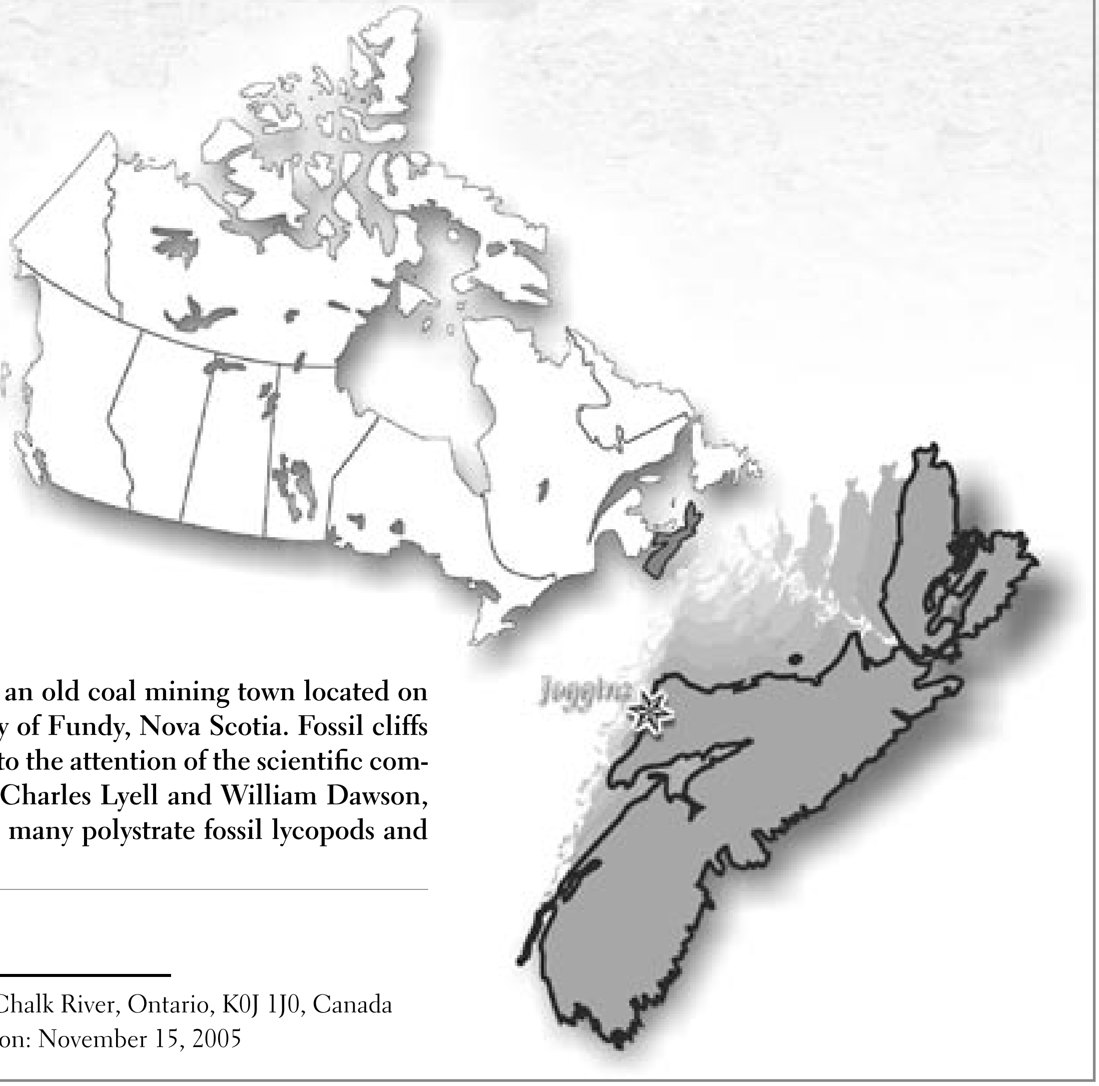

Figure 1. Joggins is an old coal mining town located on the shore of the Bay of Fundy, Nova Scotia. Fossil cliffs there, first brought to the attention of the scientific community in 1851 by Charles Lyell and William Dawson, are known for their many polystrate fossil lycopods and calamites.

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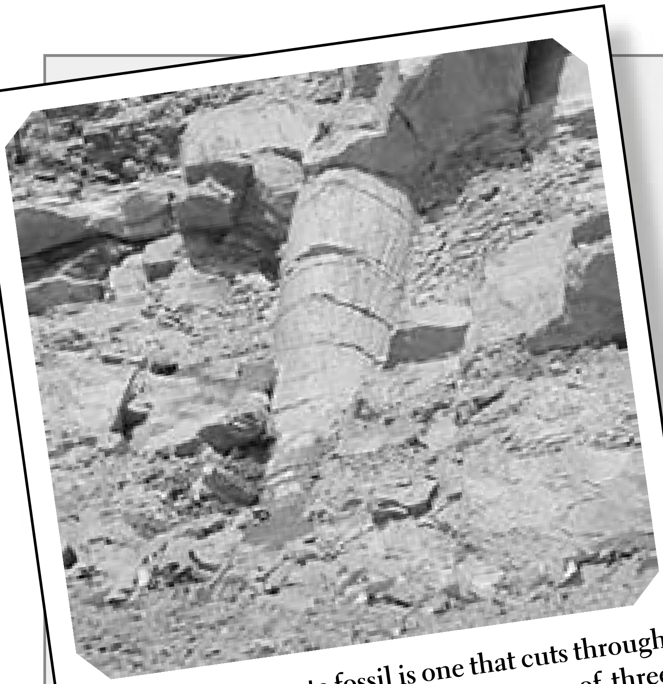

Figure 2. A polystrate fossil is one that cuts through multiple layers of rock. Over the course of three summers (2002–2004) I have studied these fossil cliffs, documenting well over 30 polystrate lycopods and dozens of polystrate calamites. In addition to the polystrate plant fossils, Joggins has many other fossils and unique geological features.

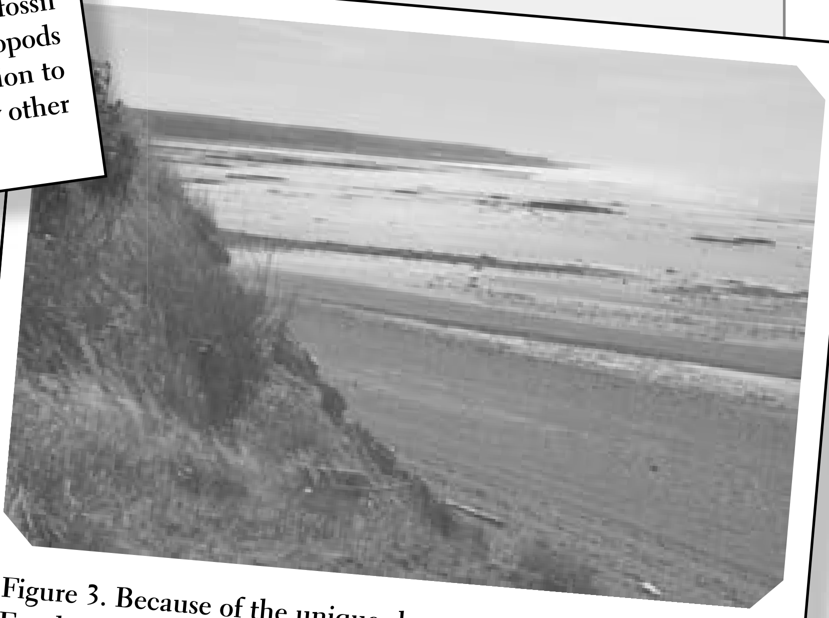

Figure 3. Because of the unique shape and direction of the Bay of Fundy, its tides are among the highest in the world, rising and retreating up to 14 meters (48 feet) twice daily. These tides continuously erode the cliffs at Joggins, constantly exposing new fossils.

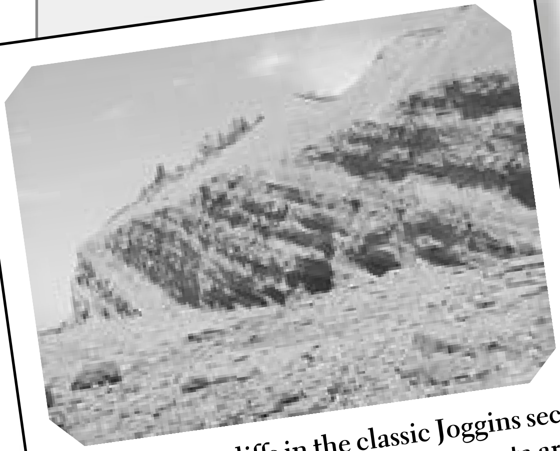

Figure 4. The cliffs in the classic Joggins section average 25 m (80 ft) high. The strata are tilted approximately 20° S. This tilt causes a 4.5 km thick section to be exposed for study along the beach between Boss Point and Ragged Reef. This section is nearly three times the thickness of strata exposed in the Grand Canyon.

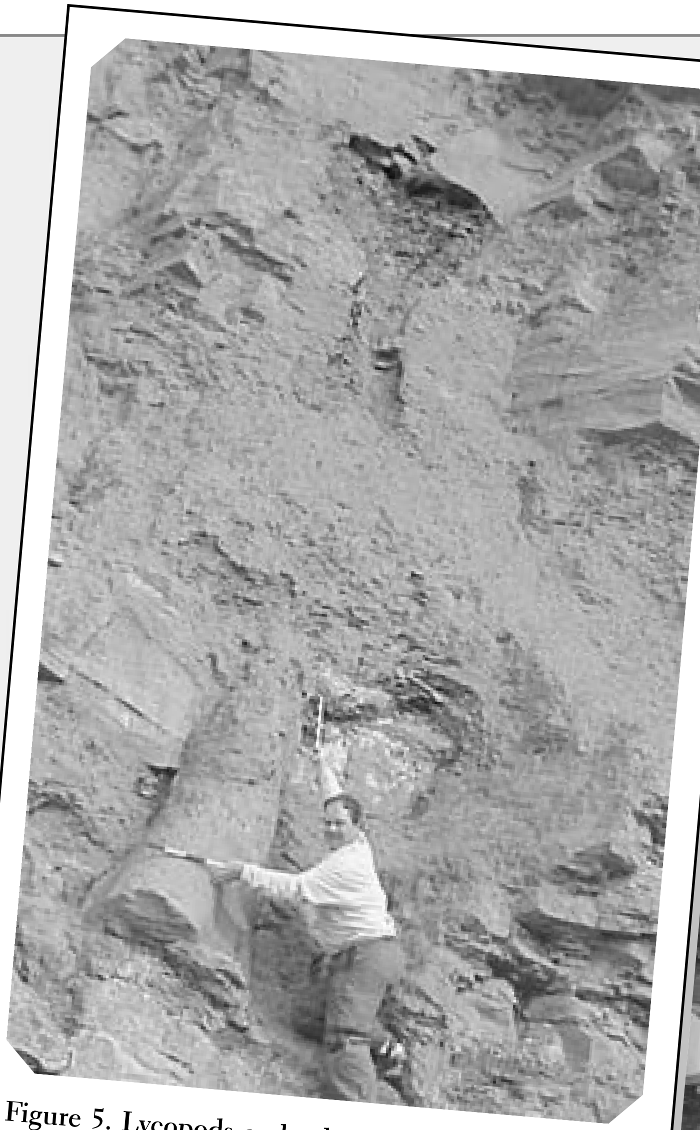

Figure 5. Lycopods and calamites were giant, hollow reeds. Both are present in a much smaller modern form. While this lycopod cuts through over 7.5 m of strata, its modern counterpart, the clubmoss, seldom exceeds 0.5 m in height. Scale in left hand is in 10 cm increments; right hand is pointing to a cavity left behind by the top of the lycopod.

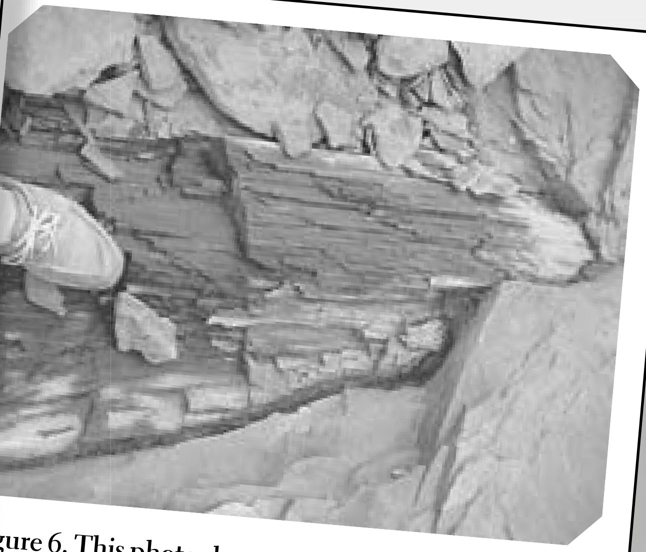

Figure 6. This photo shows one of dozens of crushed petrified trees, none of them polystrate. This is consistent with my observation that hollow reeds that preserved their shape during burial are upright to subvertical, while solid tree trunks are buried horizontally. In at least one instance, a layer with horizontal tree trunks is cut through by polystrate calamites. In three years, I have seen only one lycopod that was parallel to the bedding plane, yet not crushed.

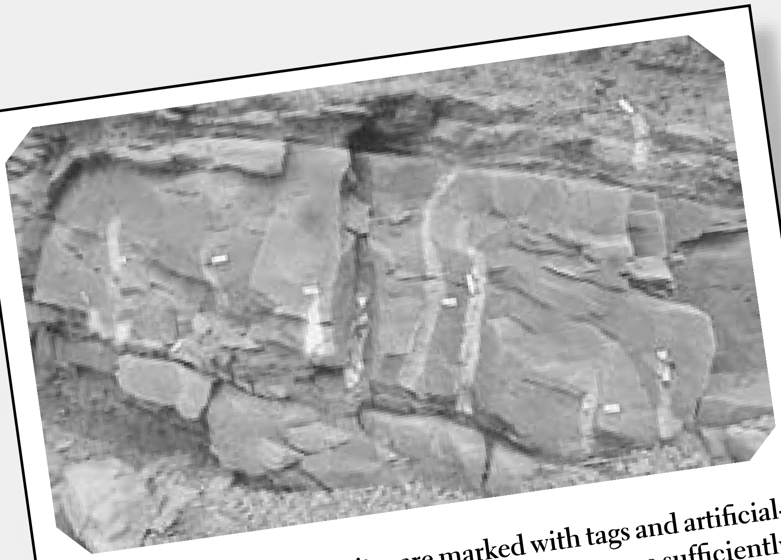

Figure 8. Polystrate calamites are marked with tags and artificially highlighted for visibility. At least six of the ten are sufficiently exposed to show that they were deformed similarly to the two in figure 7, which are just right of center in this photo.

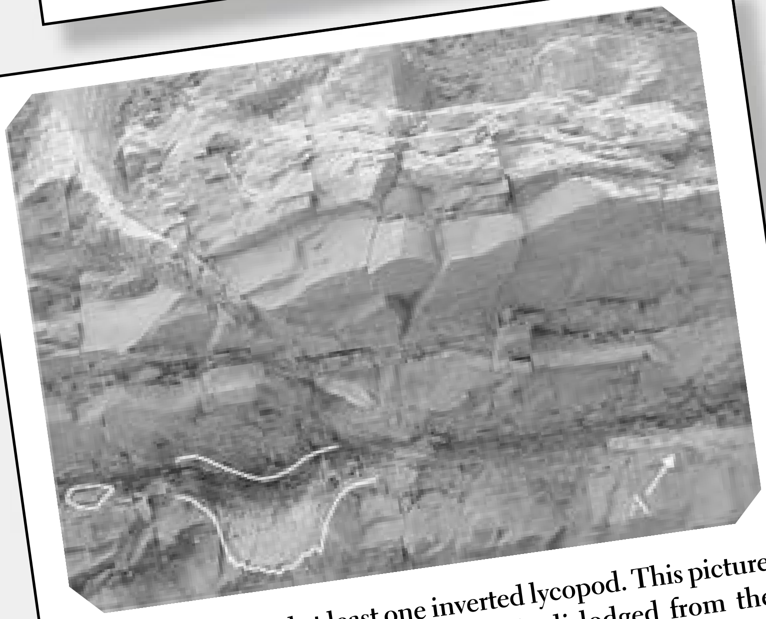

Figure 9. I observed at least one inverted lycopod. This picture shows a cavity from a lycopod already dislodged from the cliff. At least one of its roots, called stigmaria, is still in place. The inverted stump and its associated stigmaria are outlined to the lower left. The stigmaria at (A) may also have been attached to the inverted stump, or may be from the upright stump above. Any inverted stump refutes the hypothesis of Lyell (1882) that these plants were buried in their growth position. Dr. Harold Coffin (1983) also documented an inverted stump at Joggins.

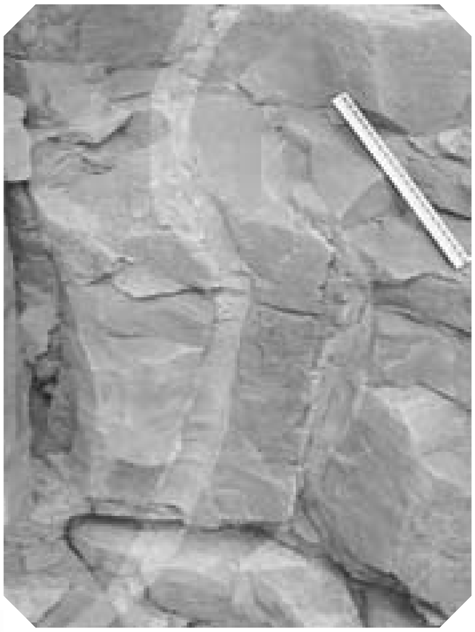

Figure 7. These two polystrate calamites, bent concordantly, were a remarkable find. They corkscrew up along a radius of about 25 cm, oriented N. Then they ascend vertically through the rock roughly 30 cm, then bend back E along a tighter radius of about 15 cm. Finally, they curl S, following a 25 cm diameter, vertical spiral path for roughly 25 cm. In experiments, I found that hollow tubes (calamites are hollow) kink when bent this tight, yet the fossils are not kinked. Therefore, these plants had to have been buried and infilled before they were bent. These two plants were part of a group of at least ten polystrate calamites (see next figure). Scale is 12 inches.

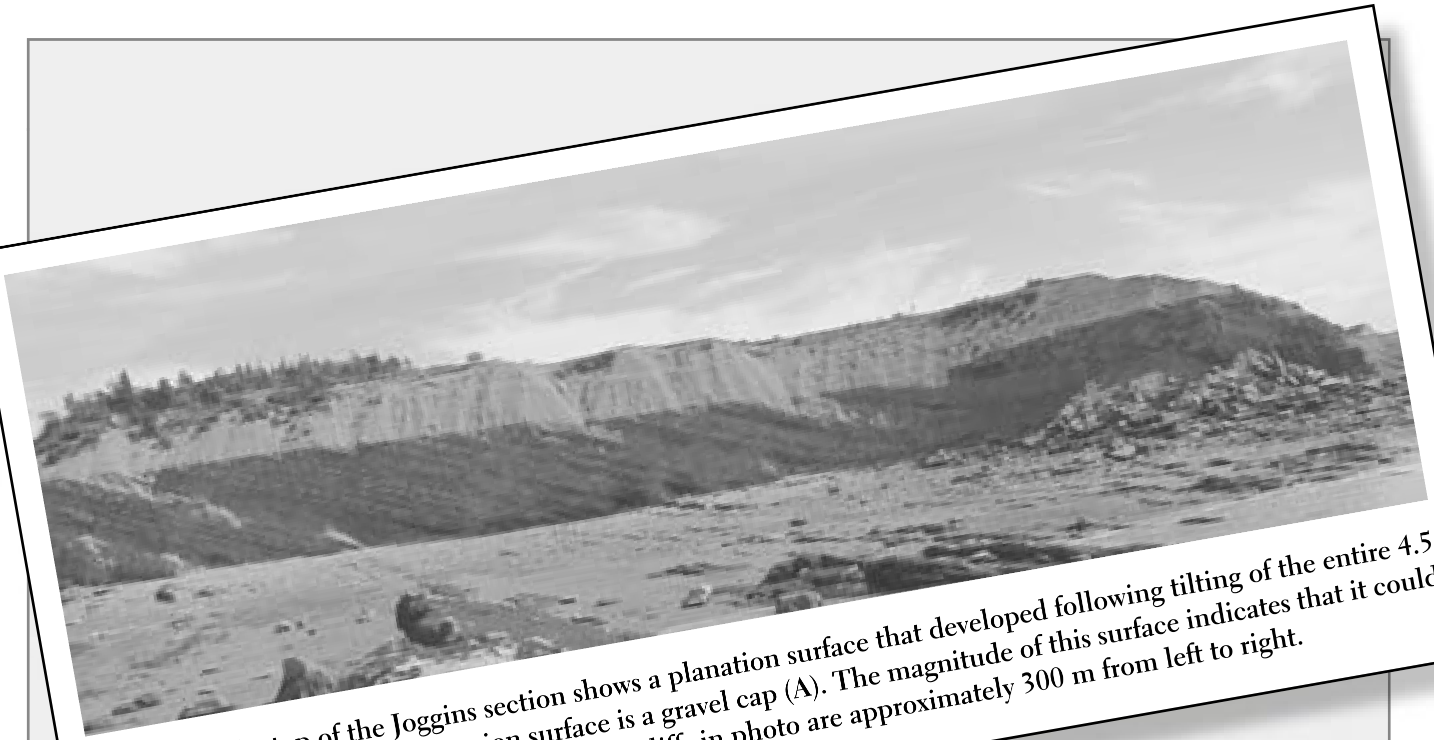

Figure 10. The top of the Joggins section shows a planation surface that developed following tilting of the entire 4.5 km-thick sequence. Atop the erosion surface is a gravel cap (A). The magnitude of this surface indicates that it could have formed during recession of floodwaters. Cliffs in photo are approximately 300 m from left to right.

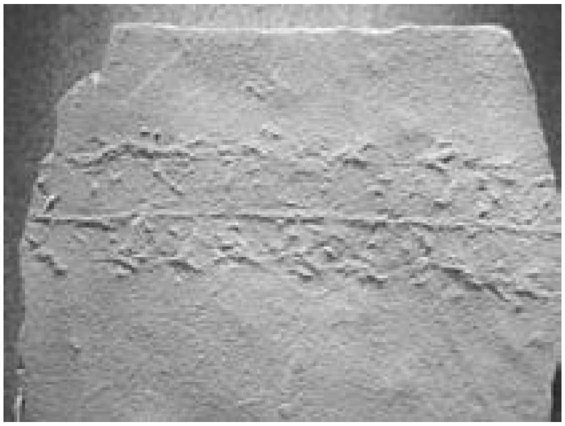

Figure 11. In addition to the polystrate fossils, the sediments at Joggins contain spectacular fossil tracks. The horseshoe crab trail in this photo is approximately 2 cm across. Currently it is legal to collect fossils from the beach, but these regulations will probably change in the near future.

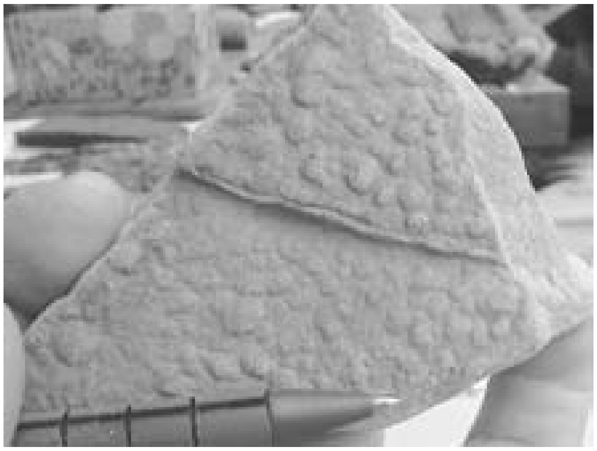

Figure 12. These impressions have been called fossil rain drop pits. This specific example was originally thought to be a cast of the rain drop layer, as it is raised bumps, not craters. After quite a bit of detective work, I finally located the original layer in situ. It turns out this was not a cast, but the top of the actual formation. Clearly rain drops are not going to produce bumps in the mud, so an alternative explanation is required. The sample provided courtesy of Laurence Tisdall.

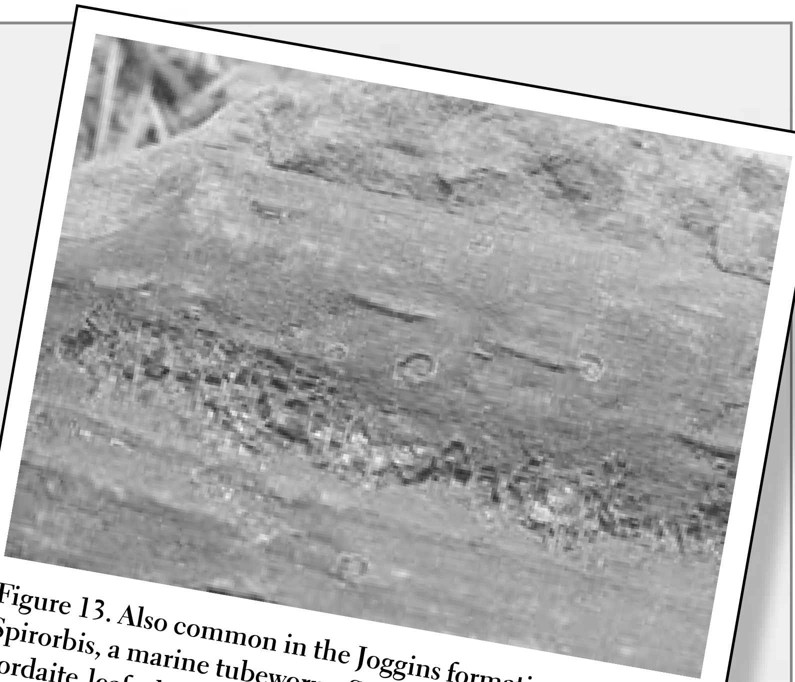

Figure 13. Also common in the Joggins formation is the fossil Spirorbis, a marine tubeworm. Seen here as spirals on a fossil cordaite leaf, this is one of the many evidences of a marine origin for the Joggins formation.

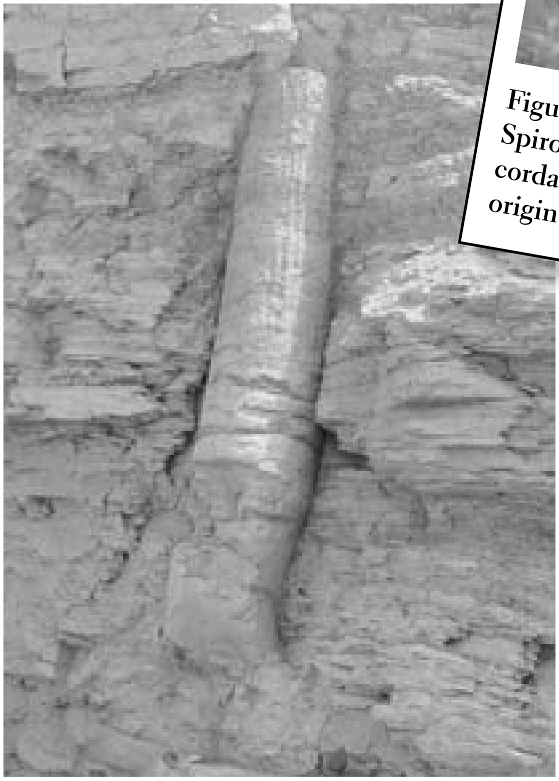

Figure 14. Regardless of how the Joggins formation came to be, it is very clear that great thicknesses of sediments do not require long periods of time. A lycopod, like the one pictured here, will not remain standing while partially buried for even decades, let alone thousands or millions of years. Additional interesting features at Joggins will be the subject of future articles for the Quarterly, but those shown here provide creationists with a brief overview of the fossil and geological evidence for the Genesis Flood at Joggins, Nova Scotia.

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Lyell, C. 1882. *Elements of Geology*. Harper and Brothers, New York, NY.

Notes from the Panorama of Science

Update on C-14 Age Calibration

A first-order approximate mathematical conversion between C-14 age and associated calendar age (real-time age) was presented in this journal in Brown (1992). Designating C-14 age in kiloyears as $\mathbf{C}_k$, and calendar age in kiloyears as $\mathbf{T}_k$, this conversion is:

$$C_k = T_k + 8.3 \ln\{1 - 0.989 \exp[-2.21(5.35 - T_k)]\}^{-1}. \qquad (1)$$

Equation (1) is based on placement of the Flood at 5350 years BP, and assumption of a simple exponential increase of upper biosphere C-14 concentration from a pre-Flood level 1.1% of the modern reference level, to 95% of the modern reference level by 4000 years BP.

Some users of this equation have preferred placement of the Flood as other than 5350 BP. Equation (2) provides convenient choice of the Flood at F years, and use of the recent determination of 0.29% for the relative C-14 equilibrium level in the pre-Flood upper biosphere (Baumgardner, et al., 2003).

$$C = T + 8300 \ln\{1 - 0.9971 \exp[-2.99(F - T)/(F - 4000)]\}^{-1}. \qquad (2)$$

Reference points from Equation (2) are: For **T** = **F**, **C** = **F** + 48,500 years; for **T** = 4000, **C** = 4,430 years. Consequently samples of pre-Flood upper biosphere material may be expected to have –C14 ages in the vicinity of 53,000 years. Any sample with C-14 age less than 53,000 years could be contaminated with pre-flood carbon. The lower C-14 age may be, the less likelihood there is for its corresponding indication of real time to be significantly modified by contamination. C-14 ages greater than around 53,000 years would indicate mixture with carbon that had not been associated with C-14.

From C-14 introduced into the atmosphere by nuclear explosions it has been possible to estimate the mean life of C-14 in the upper biosphere as approximately 375 years (Duffy, et al., 1995; Hesshalmer, et al., 1994). This estimate for the post-Flood increase in upper biosphere C-14 produces Equation (3).

$$C = T + 9300 \ln\{1 - 0.9971 \exp[-0.00267(F - T)]\}^{-1}. \qquad (3)$$

Reference points from Equation (3) are: for **T** = **F**, **C**= **F** + 48,500 years. For **T** = 4000, and **F** = 5350, **C** = 4,228 years. Within the range of approximation involved, there is no significant difference between Equations (2) and (3).

Note: For the dendrochronological conversion of C-14 age to calendar age see Calibration Issue, 2004, *Radiocarbon* 46(3).

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Brown, R.H., 1992, Correlation of C-14 age with real time, *Creation Research Society Quarterly* 29: 45–47. See Eq. (8).

Duffy, P.B., J.S. Amthor, K. Caldeira, P.S. Connell, D.E. Kinnison, J. Southon, and D.S. 1995. The global budget of bomb radiocarbon. *EOS Transactions of the American Geophysical Union* 76(46): F83, Abstract A21E-2.

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Devonian Fish and Tetrapods Support Creation—Not Evolution

The period of time on the evolutionary dating scale from 360 to 370 million years before present (my bp) is packed with fossil four-legged creatures called tetrapods, including such as *Ichthyostega*, *Acantheostega*, *Tulerpeton*, *and Hypnerpeton*. Because of this, there could have been no evolution of fish to tetrapods 360 to 370 my bp because tetrapods were "already" present.

Back at 370 my bp, two more tetrapod fossils are present—*Obruchevichys* and *Elginerpeton*. *Elginerpeton* is dated at 373 my bp, depending on the source. *Elginerpeton* specimens show signs of having been in the water, then coming out onto land for a time, and finally going back into the water (Brown, 1999 and Westenberg, 1999). To add to these, yet another tetrapod was present at that "time". The evolutionary origin of these tetrapods would have taken about 5 my and would go back to a "time" between 375 and 380 my bp, depending on the date of *Elginerpeton*. This time scenario does not include evolution from fish to tetrapod but involves only changes proposed within the tetrapods.

Panderichthyids are the fossil fish favored to have evolved into tetrapods. But the putative Panderichthyid fish ancestors made their first appearance in the fossil record only 378 my ago. This would have given only 5 my or less for fish to have evolved into tetrapods—an impossibly short time for the changes necessary to have occurred.

Furthermore, *Sinostega* is a tetrapod dated between 376.5 and 382.5 my bp. This indicates that the supposed fish ancestors of tetrapods (*Panderichthyids*), would already have been surrounded by the *Sinostega* tetrapods, an impossible situation!

But even if *Sinostega* tetrapod fossils had not been discovered, the very short time between the tetrapod *Elginerpeton* and its supposed fish ancestors (*Panderichthyids*) would have ruled out evolution from fishes to tetrapods. Tetrapods occur from 360 my bp back to 380 my bp in the evolutionary dating scheme. Some of these tetrapods, as we have seen, occur "earlier" than their supposed ancestral fish, leaving the theory of evolution dead in the water.

Acknowledgment: I thank George F. Howe for typing and for editorial assistance in the preparation of this manuscript.

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Letters to the Editor

TJ Still Available in the USA

Dear Editor,

As publishers of *TJ* (now called *Journal of Creation*), we wish to inform United States subscribers that the *Journal* is still available in their country (as is *Creation* magazine). Not knowing the names of subscribers, we are pleased to be able to let some know in this way. They would need to re-subscribe at www.CreationOnTheWeb.org/magUSA. We encourage and commend the ongoing work of the *Creation Research Society Quarterly*.

Dr. Carl Wieland
Creation Ministries International Australia
(www.CreationOnTheWeb.org)

Conference Reports

Genetics Meeting at ICR

On January 3–6, 2006, over a dozen scientists met at the Institute for Creation Research (Santee, CA) for a workshop discussing various aspects of genetics and the GENE project. (The GENE project is a joint research project of the Creation Reseach Society and the Institute for Creation Research that will focus on the human genome and other aspects of genetics relative to a creation model.) Those in attendance represented a variety of scientific expertise ranging from molecular and population genetics to computer programming and bioinformatics. Such a combination of scientific expertise and knowledge enabled in-depth discussions about a number of topics, and helped to establish important collaborations between scientists who may not normally collaborate or even communicate on specific research projects.

One area discussed at length during the workshop was the complete failure of evolution's primary axiom. This axiom states that the combination of mutations and natural selection produce evolutionary change (i.e., common descent). As more is understood about the mechanisms of both mutation and natural selection, the inability of these processes to drive evolution becomes increasingly clear: natural selection cannot create genetic diversity in the gene pool, it merely acts upon what is already present, and mutations completely fail to provide the necessary genetic change for common descent. Also, workshop attendees extensively discussed Haldane's dilemma (a mathematical model illustrating the inability of natural selection to prevent accumulation of significant numbers of negative mutations, ultimately driving all species to extinction, not to their next evolutionary stage). Evolutionists have offered a few "hand waves" as rebuttals, but knowledgeable population geneticists are fully aware that the dilemma has yet to be answered by evolutionists.

In addition, various approaches were discussed of how to study the extensive amount of information of the human, mouse, and chimpanzee genomes that are currently available. Evolutionists have made numerous claims regarding the evidence for evolution found in these genomes, and creation geneticists respectfully, but adamantly, disagree with these claims. Members of the workshop presented various aspects of the human and chimp genomes that are not readily known to the general public (or many scientists) that contradict the claims that these genomes are a product of evolutionary processes.

Another topic presented and discussed dealt with mitochondrial DNA and evolutionists' claims about "mitochondrial Eve" (the alleged mother of all modern humans based upon mitochondrial DNA analysis) who supposedly lived some 150,000 years ago. Again, creation scientists contend that the evidence has been inappropriately biased toward evolution suppositions and assumptions. Interestingly, if the evolutionary bias is removed from the interpretation of even the original data, a far younger age for "mitochondrial Eve" is calculated. One of the research initiatives of GENE will involve a laboratory study of mitochondrial DNA, which should provide sufficient data to make more correct claims about the age of "mitochondrial Eve" and how she fits into a young earth creation model.

Those attending this workshop were richly blessed in meeting, discussing, and fellowshipping with other creation scientists. Strategic plans were made for proceeding with some of the GENE research initiatives, and various collaborations were formed. This project will be the most extensive and expensive project ever conducted by creation scientists. Its completion, however, will prove extremely valuable in challenging the thinking and claims of evolutionists, and exposing the fatal genetic flaws of their arguments and conclusions.

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Creation Research Society

Addendum for the article, "An initial investigation into the baraminology of snakes." ***CRSQ*** **42:153–160.**

I want to wish my heart felt thank you to Wayne Frair, Ph.D., and George Howe, Ph.D., for numerous helpful suggestions on this article.

Tom Hennigan
Georgetown, News York

Instructions to Authors

Submission

Submit an original plus two copies of each manuscript to the editor of the *Creation Research Society Quarterly* (see the inside front cover for address). Concurrent submission of an electronic version (Word, WordPerfect, or Rich Text Format) of the manuscript text and graphics is also encouraged. The manuscript and graphics will not be returned to authors unless a stamped, self-addressed envelope accompanies submission. Manuscripts containing more than 30 pages are discouraged. An author who determines that the topic cannot be adequately covered within this number of pages is encouraged to submit separate papers that can be serialized.

All submitted manuscripts will be reviewed by two or more technical referees. However, each section editor of the *Quarterly* has final authority regarding the acceptance of a manuscript for publication. While some manuscripts may be accepted with little or no modification, typically editors will seek specific revisions of the manuscript before acceptance. Authors will then be asked to submit revisions based upon comments made by the referees. In these instances, authors are encouraged to submit a detailed letter explaining changes made in the revision, and, if necessary, give reasons for not incorporating specific changes suggested by the editor or reviewer. If an author believes the rejection of a manuscript was not justified, an appeal may be made to the *Quarterly* editor (details of appeal process at the Society's web site, www.creationresearch.org).

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Manuscripts shall be computer-printed or neatly typed. Lines should be double-spaced, including figure legends, table footnotes, and references. All pages should be sequentially numbered. Upon acceptance of the manuscript for publication, an electronic version is requested (Word, WordPerfect, or Rich Text Format), with the graphics in separate electronic files. However, if submission of an electronic final version is not possible for the author, then a cleanly printed or typed copy is acceptable.

Submitted manuscripts should have the following organizational format:

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3. Introduction. The introduction should provide sufficient background information to allow the reader to understand the relevance and significance of the article for creation science.

4. Body of the text. Two types of headings are typically used by the *CRSQ*. A major heading consists of a large font bold print that is centered in column, and is used for each major change of focus or topic. A minor heading consists of a regular font bold print that is flush to the left margin, and is used following a major heading and helps to organize points within each major topic. Do not split words with hyphens, or use all capital letters for any words. Also, do not use bold type, except for headings (italics can be occasionally used to draw distinction to specific words). Italics should not be used for foreign words in common usage, e.g., "et al.", "ibid.", "ca." and "ad infinitum." Previously published literature should be cited using the author's last name(s) and the year of publication (ex. Smith, 2003; Smith and Jones, 2003). If the citation has more than two authors, only the first author's name should appear (ex. Smith et al., 2003). Contributing authors should examine this issue of the *CRSQ* or consult the Society's web site for specific examples as well as a more detailed explanation of manuscript preparation. Frequently-used terms can be abbreviated by placing abbreviations in parentheses following the first usage of the term in the text, for example, polyacrylamide electrophoresis (PAGE) or catastrophic plate tectonics (CPT). Only the abbreviation need be used afterward. If numerous abbreviations are used, authors should consider providing a list of abbreviations. Also, because of the variable usage of the terms "microevolution" and "macroevolution," authors should clearly define how they are specifically using these terms. Use of the term "creationism" should be avoided. All figures and tables should be cited in the body of the text, and be numbered in the sequential order that they appear in the text (figures and tables are numbered separately with Arabic and Roman numerals, respectively).

5. Summary. A summary paragraph(s) is often useful for readers. The summary should provide the reader an overview of the material just presented, and often helps the reader to summarize the salient points and conclusions the author has made throughout the text.

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Robinson, D.A., and D.P. Cavanaugh. 1998. A quantitative approach to baraminology with examples from the catarrhine primates. *CRSQ* 34:196–208.

Lipman, E.A., B. Schuler, O. Bakajin, and W.A. Eaton. 2003. Single-molecule measurement of protein folding kinetics. *Science* 301:1233–1235.

Margulis, L. 1971a. The origin of plant and animal cells. *American Scientific* 59:230–235.

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Hitchcock, A.S. 1971. *Manual of Grasses of the United States*. Dover Publications, New York.

Walker, T.B. 1994. A biblical geologic model. In Walsh, R.E. (editor), *Proceedings of the Third International Conference on Creationism* (technical symposium sessions), pp. 581–592. Creation Science Fellowship, Pittsburgh, PA.

7. Tables. All tables cited in the text should be individually placed in numerical order following the reference section, and not embedded in the text. Each table should have a header statement that serves as a title for that table (see a current issue of the *Quarterly* for specific examples). Use tabs, rather than multiple spaces, in aligning columns within a table. Tables should be composed with *14-point type* to insure proper appearance in the columns of the *CRSQ*.

8. Figures. All figures cited in the text should be individually placed in numerical order, and placed after the tables. Do not embed figures in the text. Each figure should contain a legend that provides sufficient description to enable the reader to understand the basic concepts of the figure without needing to refer to the text. Legends should be on a separate page from the figure. All figures and drawings should be of high quality (hand-drawn illustrations and lettering should be professionally done). Images are to be a minimum resolution of 300 dpi at 100% size. Patterns, not shading, should be used to distinguish areas within graphs or other figures. Unacceptable illustrations will result in rejection of the manuscript. Authors are also strongly encouraged to submit an electronic version (.cdr, .cpt, .gif, .jpg, and .tif formats) of all figures in individual files that are separate from the electronic file containing the text and tables.

Special Sections

Letters to the Editor:

Submission of letters regarding topics relevant to the Society or creation science is encouraged. Submission of letters commenting upon articles published in the *Quarterly* will be published two issues after the article's original publication date. Authors will be given an opportunity for a concurrent response. No further letters referring to a specific *Quarterly* article will be published. Following this period, individuals who desire to write additional responses/comments (particularly critical comments) regarding a specific *Quarterly* article are encouraged to submit their own articles to the *Quarterly* for review and publication.

Editor's Forum:

Occasionally, the editor will invite individuals to submit differing opinions on specific topics relevant to the *Quarterly*. Each author will have opportunity to present a position paper (1000 words), and one response (500 words) to the differing position paper. In all matters, the editor will have final and complete editorial control. Topics for these forums will be solely at the editor's discretion, but suggestions of topics are welcome.

Book Reviews:

All book reviews should be submitted to the book review editor, who will determine the acceptability of each submitted review. Book reviews should be limited to 1000 words. Following the style of reviews printed in this issue, all book reviews should contain the following information: book title, author, publisher, publication date, number of pages, and retail cost. Reviews should endeavor to present the salient points of the book that are relevant to the issues of creation/evolution. Typically, such points are accompanied by the reviewer's analysis of the book's content, clarity, and relevance to the creation issue.

Creation Research Society
Membership/Subscription Application and Renewal Form

The membership/subscription categories are defined below:

1. **Voting Member** ....Those having at least an earned master's degree in a recognized area of science.
2. **Sustaining Member** ....Those without an advanced degree in science, but who are interested in and support the work of the Society.
3. **Student Member** ....Those who are enrolled full time in high school or undergraduate college.
4. **Senior Member** ....Voting or sustaining members who are age 65 or older.
5. **Life Member** ....A special category for voting and sustaining members entitling them to a lifetime membership to the Society.
6. **Patron Member** ....A special category for voting and sustaining members who either make a one-time $2,500 contribution to the Society's general fund, or contribute $500/year for five years. A Patron Member receives a lifetime subscription and is recognized annually in the *Quarterly*.
7. **Subscriber** ....Libraries, churches, schools, etc., and individuals who do not subscribe to the Statement of Belief.

All members (categories 1–6 above) must subscribe to the Statement of Belief as defined on the next page.

Please complete the lower portion of this form and mail it with payment to CRS Membership Secretary,
P.O. Box 8263, St. Joseph, MO 64508-8263, or fax credit card payment to (816) 279-2312.

Applications may also be completed online at creationresearch.org.

This is a ☐ new ☐ renewal application for the subscription year beginning June ☐ 2006 ☐ __________.
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Volume	1	2	3	4
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33	☐	☐	☐	☐
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Members, $100; nonmembers and subscribers, $115.
Upgrade: Members, $45; nonmembers and subscribers, $60. (Prices on this item include postage and handling.)

Two-set CD contains volumes 1–41 (through March, 2005) of the *Creation Research Society Quarterly* and volumes 1–9 (through December, 2004) of *Creation Matters* in Adobe Acrobat format.

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Creation Research Society

History—The Creation Research Society was organized in 1963, with Dr. Walter E. Lammerts as first president and editor of a quarterly publication. Initially started as an informal committee of 10 scientists, it has grown rapidly, evidently filling a need for an association devoted to research and publication in the field of scientific creation, with a current membership of over 600 voting members (graduate degrees in science) and about 1000 non-voting members. The *Creation Research Society Quarterly* has been gradually enlarged and improved and now is recognized as the outstanding publication in the field. In 1996 the *CRSQ* was joined by the newsletter *Creation Matters* as a source of information of interest to creationists.

Activities—The Society is a research and publication society, and also engages in various meetings and promotional activities. There is no affiliation with any other scientific or religious organizations. Its members conduct research on problems related to its purposes, and a research fund and research center are maintained to assist in such projects. Contributions to the research fund for these purposes are tax deductible. As part of its vigorous research and field study programs, the Society operates The Van Andel Creation Research Center in Chino Valley, Arizona.

Membership—Voting membership is limited to scientists who have at least an earned graduate degree in a natural or applied science and subscribe to the Statement of Belief. Sustaining membership is available for those who do not meet the academic criterion for voting membership, but do subscribe to the Statement of Belief.

Statement of Belief—Members of the Creation Research Society, which include research scientists representing various fields of scientific inquiry, are committed to full belief in the Biblical record of creation and early history, and thus to a concept of dynamic special creation (as opposed to evolution) both of the universe and the earth with its complexity of living forms. We propose to re-evaluate science from this viewpoint, and since 1964 have published a quarterly of research articles in this field. All members of the Society subscribe to the following statement of belief:

1. The Bible is the written Word of God, and because it is inspired throughout, all its assertions are historically and scientifically true in all the original autographs. To the student of nature this means that the account of origins in Genesis is a factual presentation of simple historical truths.
2. All basic types of living things, including humans, were made by direct creative acts of God during the Creation Week described in Genesis. Whatever biological changes have occurred since Creation Week have accomplished only changes within the original created kinds.
3. The Great Flood described in Genesis, commonly referred to as the Noachian Flood, was a historical event worldwide in its extent and effect.
4. We are an organization of Christian men and women of science who accept Jesus Christ as our Lord and Savior. The act of the special creation of Adam and Eve as one man and woman and their subsequent fall into sin is the basis for our belief in the necessity of a Savior for all people. Therefore, salvation can come only through accepting Jesus Christ as our Savior.